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EDITORIAL

Accent on Salvage

IN THE drive for rounding up all the available scrap metals, at least a few engineers see danger of discarding machines or parts, particularly the latter, which may be made usable and which may be urgently needed before adequate amounts of materials again are available to the farm equipment industry. Normally, no doubt, it is more economic as well as more efficient to put on a new share than to sharpen an old one too often. Now it may be a question of an old share vs. no share at all.

When there was plenty of steel and plenty of machine-tool capacity to make repair parts, America had no need to learn how to reclaim old parts. Now it might well be wise to adopt a general policy of requiring a trade-in of replaced parts. The mail-order houses and automotive jobbers have shown how to use a coupon system for trade-ins without inconvenience or delay to the customer. The main purpose of the trade-in system is to get the junk into hands where experts can decide what is subject to salvage before releasing the remainder to the foundries.

By a sort of counterflow arrangement, worn parts can be routed back to the factories or diverted to specialty shops if and as reclamation is feasible. Industry and government can decide whether tractor valves shall be refaced with stellite and piston pins built up with hard chromium, or simply ground to undersizes and mated with undersize seat rings or bushings. A bronze-back main bearing should be worth more to the nation if returned to the factory which made it than if tossed into a general scrap heap.

Experience with the collapsible tin tube showed the psychological necessity for the trade-in principle, even where only scrap value was involved. It is all the more important where there is a possibility of salvage.

Encourage Custom Work

WITH the decline of the steam traction engine and grain thresher came the disappearance of the custom operator of farm machines. Custom operation of any and all farm machines can and should increase the annual capacity of the limited amount of machinery available. Custom use of some machines, notably the combine, has continued on a reduced scale. However, the point is made that such custom work usually was done by the boys of the farm family, and now those boys are in the armed services, in defense factories, or are indispensable at home.

From the ranks of the farm machinery trade has come the proposal that dealers step into the breach and operate machinery on a custom basis. Of course, they can do so only when not busy at their primary function of servicing machinery, and only if they can get hold of machines to operate. A few dealers might resist both the clamor of customers and the pressure of the government to retain or secure machines for custom use, and thereby render a greater service to clientele and to country.

More promising is the possibility of utilizing the surplus capacity of farmer-owned machines, the dealer taking hold before or after home-farm work use of the machine. Combines, pickup hay balers, corn pickers, peanut machines, and tractors to pull them are examples of equipment which should be pressed into custom work so far as feasible. Dealers or their expert employes are in a position to command the confidence of both the customer and the owners of the machines.

In fairness to all parties, there should be formulas for equitable charges for custom work, and their allocation between operator and machine owner. Agricultural engineers, both of the machinery manufacturers and in the colleges, can render a service by arriving at such formulas and making them known. Extension engineers, particularly, can stimulate such a mobilization of machinery to meet the emergency.

Foci of Inflation

IN AGRICULTURAL ENGINEERING for April, Arnold P. Yerkes proposed the shift of farm workers from areas of inefficient production to more efficient areas and to war industries. In his address to the retail farm machinery trade's conference or clinic at Chicago on April 28, Dr. J. B. Davidson touched on such transfers to more efficient farms as one of several expedients to expand food production, or at least to maintain it, despite the handicaps of war conditions.

At this latter conference the field secretary of the Illinois Agricultural Association reported that between the draft and the war factory, the foot-loose or single man was a thing of the past as a farm hired man; moreover, that in the defense plant areas even the permanent or married type of farm help had been largely drained away, and in areas where it remained its cost was 50 per cent higher than a year before. Indeed, some farmers are seeding down their land and seeking defense jobs in the cities. This is no way to enlarge food production in the face of machinery shortages.

As war industry passes more and more from the tooling-up stage to mass production, the exodus from farm to factory will become more acute. Since food and its cost are fundamental in the level of the national economy, the defense plant appears as a focus of inflation. So far as is feasible at this late date, munitions manufacture should be diverted to areas of the least agricultural importance, i.e., where manpower is least effective in food production. This would minimize not only the inflationary influence but also the need for moving of labor to the efficient areas, under the Yerkes proposal.

Application of this principle will involve quantitative appraisal of the productivity of labor and availability of machinery in all agricultural areas. This is an agricultural engineering job, and the profession should be ready to give the government authentic data and counsel on short notice.

"Controlling Erosion in Farm Drainageways"

To the Editor:

I WOULD like to make some comments on the article, entitled "Controlling Erosion in Farm Drainageways," a contribution of the ASAE Subcommittee on Erosion Control and Farm Drainageways, which appeared in the April 1942 issue of AGRICULTURAL ENGINEERING.

This paper is a good summation of general knowledge on this subject. However, I do not believe that this is enough. A contribution by a committee of the Society should represent the best information available on a subject. The treatment should be thorough and the recommendations specific. The contribution should set the standard for good practice for the agricul- *(Continued on page 174)*

AGRICULTURAL ENGINEERING

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Performance of Cowls for Ventilated Grain Bins

By C. F. Kelly, M. G. Cropsey, and W. R. Swanson
MEMBER A.S.A.E. MEMBER A.S.A.E.

MOST ventilated grain bins on the market are designed to utilize the wind either to force or draw air through the stored grain to dry and cool it. A cowl or revolving ventilator is usually supported above the bin and connected by a duct to the system used for the distribution of air through the grain. Rotating ventilating cowls may be divided into two general types, namely, (1) pressure cowls, which face the wind and develop positive pressures, and (2) suction cowls or ventilators, which utilize the wind for producing suction or negative pressures. In this latter classification are included various types of cowls facing away from the wind, and turbine ventilators. The two general types of cowls are shown in place on bins in Fig. 1.

The performance of ventilating cowls on grain bins may be measured by the magnitude of either positive or negative pressures which they develop from winds of various velocities, and by their effectiveness in preventing the entrance of snow or rain. Various investigations[1,2]* have been made of the performance of ventilating cowls for livestock and other structures, in which the amount of air moved against very low heads was the principal consideration. Calderwood and Mack[1] measured the velocity of the air drawn up through various types of suction ventilators by negative pressures induced by outside air movements at several different speeds. The resistance offered to the flow of air was that through the ventilator itself and through a round pipe 10 in in diameter and about 3 ft in length. Needless to say this resistance is negligible compared to that offered by several feet of grain.

In livestock structures large volumes of air are moved against low resistances, while in grain bins relatively smaller volumes are moved against much greater resistances. For the latter case no data are available, and it was for this reason that the Bureau of Agricultural Chemistry and Engineering of the U. S. Department of Agriculture, during the winter of 1940-41, conducted a series of tests at the North Dakota Agricultural Experiment Station at Fargo to determine (1) the pressures developed by various types of ventilators at several different wind velocities, and (2) the effectiveness of different cowls and duct systems in preventing snow from reaching the grain. This paper describes these tests together with their results, and also gives observations made on ventilators in bins at the Fort Hays Experiment Station, at Hays, Kansas.

Four types of ventilators, two pressure and two suction, and three different types of duct systems to carry air to or from the grain were tested at Fargo, N. D. These are illustrated in Fig. 2. A, B, and C were the same in so far as the cowl was concerned, but differed with regard to the type of duct system carrying air to the wheat. A had a plain pressure cowl, kept facing into the wind by a vane which was connected to the wheat through a vertical straight pipe. B had a pressure cowl of the same design, but a damper and "T" were placed in the duct system to prevent rain and snow from being blown into the grain. The bottom part of the "T" was closed off, except for a small nail-hole to let rain or the water from melting snow drip out before reaching the grain. C also had a plain pressure cowl, but between the cowl and the wheat were both a "T" trap, closed at the bottom except for a small hole, and a "U" trap to prevent rain and snow from reaching the grain.

The ventilators of D, E, and F were of different types, but all were connected to the grain by the same type of straight vertical duct system as used with A. D had a pressure cowl facing the wind, which was provided with louvers as shown in Fig. 2 to exclude rain and snow. E had a suction ventilator of turbine design, and F had a suction cowl kept facing away from the wind by a vane. The projected area of the cowl faces for A, B, C, and F was 155 sq in and that for D was 324 sq in. The turbine ventilator in E was 12 in in diameter.

The cowls were set on stands in a flat field having good exposure in all directions. All cowls were placed 13 ft above the ground, approximately the distance they would have been if placed on a 1000-bu metal grain bin. All ducts were 12 in in

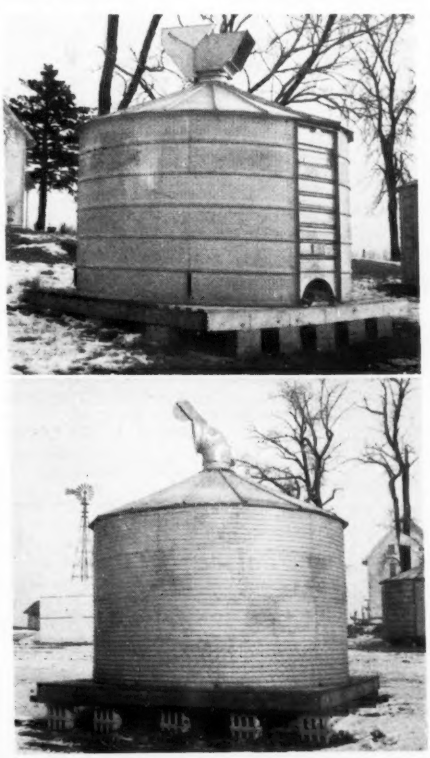

Fig. 1 Views of the two general types of cowls in place on bins: (Top) Pressure cowl kept facing into wind by vane; (Bottom) suction cowl kept facing away from wind by vane

Paper prepared especially for AGRICULTURAL ENGINEERING. Authors: Respectively, associate agricultural engineer, junior agricultural engineer, and assistant agricultural engineer, Bureau of Agricultural Chemistry and Engineering, U. S. Department of Agriculture.

*Superscript figures refer to bibliography appended to this paper.

diameter, except for the louvered cowl (in D) which had a diameter of 18 in. The throat diameter of all cowls except two was 12 in; that of the turbine ventilator (in E) was 10 in, and that of the louvered cowl (in D) was 18 in.

The resistance to air flow was the same in each case, being that offered by 18 in of wheat supported in the lower end of the duct on fly screen over hardware cloth. Eighteen inches is less than the thickness of grain usually encountered in ventilated bins, but this thickness was chosen because a comparison of the amounts of air forced through different thicknesses of wheat by various static pressures[3] indicated that, due to the very low velocity of the air through the wheat, the static pressures developed against all thicknesses of grain over one foot are about the same, under similar conditions of wind velocity.

It should be remembered that the static pressure developed by a cowl will be the velocity pressure of the wind less the velocity pressure of the air in the duct system and less losses due to air friction caused by eddies. The resistance due to the various lengths of pipes, elbows, etc., was shown by observations to be very small compared to that offered by the wheat. Therefore, this resistance can be disregarded.

Positive or negative pressures were observed by means of Pitot-static tubes inserted in the duct 6 in below the cowl and 6 in above the level of the wheat. The tubes were connected to a Hays draft gage reading –0.1 to +0.5 in of water. Inaccuracies of observations due to air movement past the pressure equalizing opening in the instrument cover were minimized by setting the gage in a large glass jar. The wind speed was measured by means of a vane anemometer supported on a rod two feet to one side and slightly ahead of the ventilator being tested, and at the same level. The mean wind speed was determined from the amount of wind passing the anemometer over periods of 2 to 10 sec duration. At the same time the wind speed was being taken, the static pressure was being observed on the pressure gage. Because of variations in wind speed and direction it was almost impossible to obtain simultaneous readings of wind speed and pressure, and it was necessary to use the averages for short periods. An effort was made to delay the readings until the wind was steady and also to obtain readings of pressures produced by a wide range of wind speeds. The damper in the duct below the pressure cowl in B was open when pressure observations were made.

The relation between the wind speed and the observed pressure developed in the cowls is shown by curves in Fig. 3. No distinction is made in Fig. 3-A between the pressure readings obtained on the different systems, A, B, and C, or between the readings obtained just below the cowl and just above the wheat, because no appreciable differences apparent. However, the data from the pressure cowl with louvers (in D) are distinguished from those of the others because of the larger throat diameter of this cowl and the fact that the pressure readings were erratic. In Fig. 3-B the data from the turbine suction ventilator (in E) are distinguished from those of the suction cowl (in F).

It may readily be noted from Fig. 3 that the positive pressures developed by the pressure cowls are much larger than the negative pressures developed by the suction ventilators. While more specific comparisons for the two general types of ventilators can be made for each of a number of different wind speeds, a general or overall comparison can well be made by comparing the regression curves for the observed data of each of the two general types of cowls. These are shown as solid lines in Fig. 3 and have been fitted to the observed data by the method of least squares. The broken line curves represent the maximum theoretical velocity pressures (positive and negative) which can be developed by the wind.

It is readily apparent from an examination of Fig. 3 that the pressure type of cowl develops nearly the full

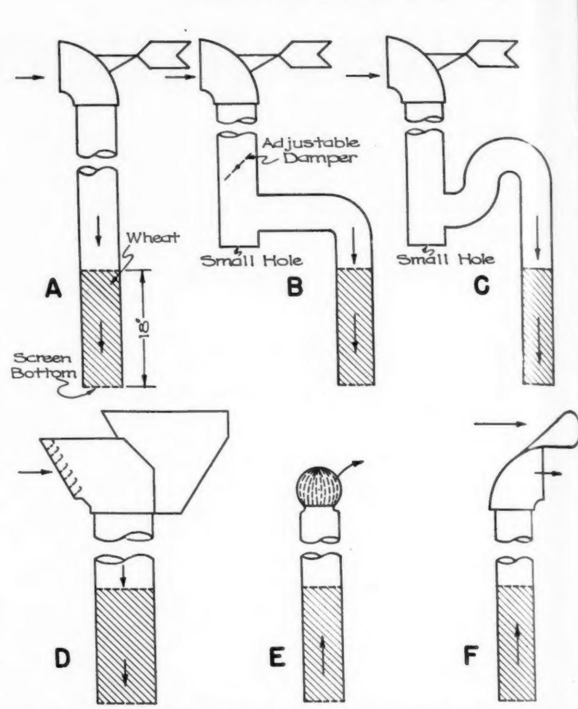

Fig. 2 Diagram of ventilators and duct systems tested at Fargo, N. D.: A, plain pressure cowl with straight duct; B, plain pressure cowl with damper and "T" in duct; C, plain pressure cowl with "U" trap in duct; D, louvered pressure cowl with straight duct; E, turbine suction ventilator with straight duct, and F, plain suction cowl with straight duct

TABLE 1. SNOWFALL, HIGHEST WIND VELOCITY, AND AMOUNT OF SNOW REACHING WHEAT (IN POUNDS) IN VARIOUS COWLS AND DUST SYSTEMS TESTED AT FARGO, N. D., IN THE WINTER OF 1940-41

Period (Dates)	Snowfall during period[a], in	Highest wind velocity during period[b], mph	Type of Cowl and Duct System[c] A (lb of snow)	B (lb of snow)	C (lb of snow)	D (lb of snow)	E (lb of snow)	F (lb of snow)
Dec. 5 to 7	.1	27	0.2	0.0	[d]	[d]	0.0	0.0
Dec. 8 to 14	.7	24	.6	.0	[d]	[d]	trace	trace
Dec. 15 to 21	trace	17	.0	.0	[d]	[d]	.0	.0
Dec. 22 to 29	4.2	17	.0	.0	[d]	[d]	.0	.0
Dec. 30 to Jan. 11	7.6	22	1.6	.0	[d]	trace	trace	trace
Jan. 12 to Jan. 29	3.3	20	1.7	.0	[d]	trace	.0	trace
Jan. 30 to Feb. 10	.4	21	.8	.0	[d]	0.1	trace	[d]
Feb. 11 to Feb. 15	.1	27	.0	.0	[d]	.0	.0	[d]
Feb. 16 to Mar. 1	2.8	23	.6	[d]	0.0	trace	.0	[d]
Mar. 2 to Mar. 7	1.3	20	1.4	[d]	.0	.7	trace	[d]
Mar. 8 to Mar. 13	.5	16	.6	[d]	.0	.2	.0	[d]
Mar. 14 to Mar. 17	.8	41	10.2	[d]	[e]	15.2	6.2	[d]

[a]Unmelted.
[b]From records of Weather Bureau at Moorehead, Minn. Records from airport near experiment site indicated wind velocities as high as 70 mph during short periods.
[c]See Fig. 2 for drawings of various types of cowls and duct systems.
[d]Not being tested during this period.
[e]Duct system blown down by high wind in blizzard of March 15, 1941.

theoretical velocity pressure, but the suction type of cowl develops only a fraction of the theoretical negative pressure. Appropriate comparisons of the performance of the cowls can be made from the values for K in the equation $P = KV^2$ giving the relationship between the pressure P and the wind velocity V. The K values for the different equations when P is in inches of water and V in miles per hour, are as follows:

Theoretical maximum velocity pressure, $K = 0.000483$

Regression equation for pressure cowls, $K = 0.000430$

Regression equation for suction cowls, $K = 0.000170$

In case of the pressure type cowls, the ratio of the K in the regression equation to that of the theoretical equation is 0.892; in case of the suction type cowls it is 0.352. This indicates that the pressure type cowl develops about 89 per cent of the theoretical positive pressure, and the suction type cowl develops about 35 per cent of the theoretical negative pressure over the range of wind speeds observed. In other words, the pressure type of cowl is about two and one-half times as effective in developing a head for creating movement of air through grain as the suction type, providing the resistance to air flow is the same.

Pressure and wind speed observations made at Hays, Kansas in November 1939 and March 1941 on suction and pressure cowls installed on full-size bins filled with wheat and grain sorghum, indicated about the same relation between these two factors as is shown in Fig. 3. Measurements on four bins equipped with pressure cowls indicated development of average pressures of 0.022 in of water at 8 mph wind velocity, 0.042 in at 10 mph, and 0.080 in at 16 mph. In two bins having suction cowls, the average negative pressure developed at 8 mph wind velocity was 0.010 in of water and at 16 mph, 0.015 in.

The test cowls at Fargo were arranged so that the amount of snow blowing into the cowl and reaching the wheat could be measured during the winter months. A small door was cut into the duct a few inches above the wheat line so that after a storm the snow blown in could be removed and weighed. The weight of snow caught by each ventilator in various periods is shown in Table 1, along with the total amount of unmelted snowfall and the highest wind velocity recorded during the period. Unfortunately all systems were not on test simultaneously, as only four stands were set up. The damper in the vertical duct of system B having an open-face cowl was kept closed during this part of the experiment.

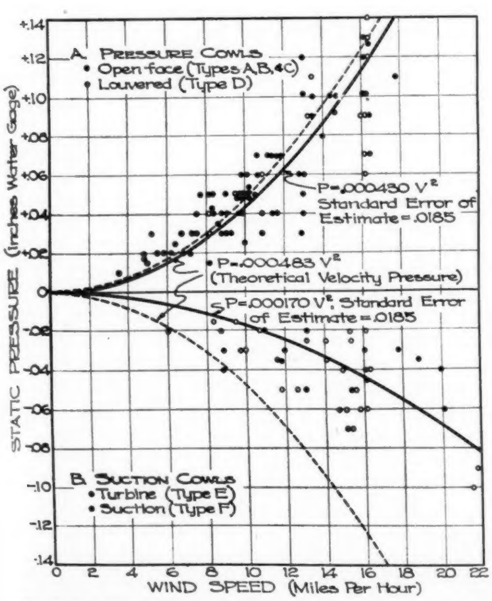

Fig. 3 Relation between wind speed and static air pressure developed in grain bin ventilators: A, for pressure cowls; B, for suction ventilators

As was expected, system A having a pressure cowl with open face and straight vertical duct allowed more snow to reach the wheat during periods with ordinary wind velocities than any other system. System B, with the damper in the duct, was very effective in keeping out snow, as were all other systems supplying pressure and suction ventilators up to March 1. In the period March 2 to March 17, during which the March 15 blizzard occurred, all the ventilators being tested admitted large quantities of snow to the wheat. It is probable that the greater amount of snow caught by the cowl having louvers, in system D, was due to the larger area facing the wind.

The amount of snow entering ventilating systems on full size bins was also measured at Hays, Kans., during the winters from 1939 to 1941. In December 1939, seven inches of snow fell during a period of a few days. The wind velocity averaged only 5 mph, but in one ventilating system similar to type B, with exception of damper, the snow had blown into the horizontal duct for a distance of about 4 ft and had filled the elbow connecting the vertical to the horizontal pipes three-fourths full. Similar conditions were observed in other bins at that time. None of the cowls had louvers over the openings facing the wind. In January 1941, a $2\frac{1}{2}$-in snow accompanied by winds averaging 14 mph, deposited about $\frac{3}{4}$ in of snow in the bottoms of horizontal ventilator ducts connected to open face pressure cowls. However, no snow entered a pressure cowl with louvers, similar to that in D of Fig. 2.

SUMMARY AND CONCLUSIONS

1 In tests of four different types of bin ventilators, two pressure and two suction, at Fargo, N. D., it was found that the air pressure developed by the pressure cowls closely approached the velocity pressure of the wind, but that the negative pressures developed by a turbine ventilator and a suction cowl were only about 40 per cent as great. In other words, pressure cowls are about two and one-half times as effective in developing head or pressure from wind for use in creating air movement through grain.

2 None of the cowls or duct systems tested, except B and C which were not on test during periods of highest winds, excluded all snow, indicating that ventilators should be closed during the winter months. It was observed that in storms with ordinary wind velocities louvers were of benefit in excluding snow from pressure cowls and that the suction ventilators did not catch as much snow as the open face pressure cowls.

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Water-Disposal Planning Techniques

By William A. Weld
MEMBER A.S.A.E.

WATER-DISPOSAL planning technique has been improved greatly during the eight years that a soil conservation action program has been in operation in the southeastern region of the United States. For the most part, the changes may be attributed to a broader understanding of the problems involved and experience gained during that time. Likewise, many other phases of the program have undergone progressive changes. For the purpose of this paper, however, only those phases that have a bearing on water disposal will be considered.

One of the most promising developments in water-disposal planning technique has been the recent adaptation of stereoscopic delineation and analysis of natural drainage features on aerial photographs, as an initial step in the planning process. This, however, is only one of a long series of steps in a process by which the present methods of water-disposal planning have been developed.

During the early stages of the soil conservation demonstration projects in the Southeast, sufficient emphasis was not placed on the correlation of water-disposal planning with land-use planning. Upon completion of the soil survey of a farm, the farm was visited by the project soil conservationist. A plan was prepared covering overall recommendations relative to land conversion, field organization, crop rotations, designation of fields to be terraced, and other changes to be effected in carrying out an erosion-control and better land-use program.

Following through with this order of procedure, the detailed work plans for engineering, as well as the other technical phases, were then developed after the farm had been planned. From this it can be seen that most problems of water disposal were approached from the standpoint of designing and laying out the disposal system to fit an already planned land-use program.

One of the undesirable results of this procedure was that an unnecessarily large number of excavated terrace outlet channels was incorporated into the first farm conservation plans. This resulted, for the most part, because existing field boundaries, roadways, and fences were taken for granted as permanent divisions. There also was too great a tendency to plan the terracing system independently, field by field, rather than to consider the entire farm or drainage area as a basic unit.

In the majority of cases, the design, excavation, and treatment of terrace outlet channels were not initiated until after the terraces had been constructed. Various methods were employed in an attempt to stabilize these outlets. Such treatment was expensive, even under most favorable working conditions. In an attempt to arrive at a reasonable cost per acre, the run-off from an excessively large drainage area oftentimes would be concentrated into one channel. Such a condition intensified the already difficult problem of stabilizing these restricted channels, and further necessitated accurate designing by a trained engineer. In the end, it was found extremely difficult for the farmer to maintain these waterways adequately following the initial construction and treatment.

Paper presented February 4, 1942, at a meeting of the Southern Section of the American Society of Agricultural Engineers at Memphis, Tenn. Author: Assistant chief, regional engineering division (Region 2), Soil Conservation Service, U. S. Department of Agriculture.

A noticeable weakness in early conservation plans was the lack of supporting practices on crop land. Owing to the character of the terrain in this region, abrupt slope changes occur frequently. Such critical areas, interspersed within larger areas of moderate rolling topography, constituted a serious erosion problem that was not solved by terracing and annual crop rotations. The excessive soil loss and rapid concentration of water on these steeper sections of the field clogged and overtaxed the terraces, with the result that they failed, causing serious erosion farther down the slope.

Experience gained during the first years of the action program clearly indicated the need for placing greater emphasis on water-disposal planning as a basic step in the development of complete farm conservation plans. By so altering the procedure, due consideration is given to adjusting land use to fit a sound water-disposal plan that topography determines. The preparation of an overall water-disposal plan for each farm likewise insures the integration of all measures related to water disposal into a coordinated system. Practices that generally are considered as integral parts of the water-disposal system include stabilized waterways, terraces, diversion channels, row layout, perennial strips on critical slopes, farm and field roads, fences, drainage facilities, field borders that provide controlled row drainage, and farm ponds. These measures when planned and established provide a skeleton or framework around which other conservation practices may be developed. Furthermore, such measures represent permanent features when once established, and it is extremely important that they be properly located.

Another significant change in water-disposal planning took place early in 1936. It always has been a basic policy to utilize existing woodland, permanent pasture and hay land, and other well-stabilized areas on which the concentrated run-off from terraces can be disposed of safely and spread. Of course such areas are not accessible always at the proper locations to serve this purpose. However, by adjusting land use to fit the requirements for adequate run-off control, it would be possible to convert to a suitable type of perennial vegetation those natural drainageways passing through or adjacent to cultivated fields. The terms "meadow outlet" and "disposal area" came into being to define this practice. In the majority of cases these areas are now being converted to perennial hay crops, such as kudzu, lespedeza sericea, or a grass mixture, which serve the dual purpose of conducting run-off from terraces to a stabilized gradient farther down the slope, and at the same time yield a tangible return to the farmer in the form of hay or temporary grazing. Topography determines the minimum limits of such areas beyond which size is dependent on obtaining an economical hay-producing unit. Under favorable conditions, pasture land or woodland may be extended to provide necessary disposal facilities.

These land-use changes, which provide water-disposal measures, have practically eliminated the need for excavated terrace outlet channels. Several outstanding advantages result from this change. Design is greatly simplified because the water is spread over a wide area having several times the required carrying capacity. The land is prepared

and the area well stabilized with perennial vegetation through the use of available farm labor and equipment. Maintenance is insured because the farmer realizes a direct return from the production and harvesting of hay crops. This last operation likewise is carried out as a regular part of his farm work with available equipment.

Along with land conversion to provide for water-disposal outlets, emphasis is now placed on the treatment of critical areas within cultivated fields. Where abrupt changes in slope occur, terrace maintenance is difficult under clean cultivation. It is now a recommended practice to establish perennial strips on these areas, and likewise on long continuous slopes. Where such areas adjoin disposal areas, the same type of vegetation is used in both, where practical, to facilitate maintenance. Stabilization of these critical areas greatly assists in providing more adequate control of erosion on the field, and at the same time strengthens the terrace system through improved performance and reduced maintenance.

More thought is being given to the location of farm and field roads, so that they will fit into a coordinated system. The objective is to provide access to all parts of the farm over a network of field roads located on the contour or at the point of minimum run-off concentration. A serious erosion menace is eliminated by this step. Likewise, fences running through or adjacent to cultivated fields are relocated to fit the adjusted water-disposal and land-use pattern. Adequate provisions are also made for the stabilization of road banks, side ditches, and shoulders where run-off from terraces and row ends must discharge. This treatment also provides an effective turn row at the edge of the field.

It is obvious that the installation of the measures that have been discussed heretofore calls for an action program of major proportions. Owing to the interdependence of the various practices and the seasonal limitations affecting establishment, it is important that a work schedule be developed in connection with each farm plan to insure the execution of the program in an efficient manner. This schedule, which is prepared jointly by the planning technician and the farm operator, takes into account the sequence in which the various practices should be established, and distributes the work over a period of years in line with the farmer's ability to carry out the program according to his available labor, equipment, and power facilities.

In the work schedule those changes in land use that affect water disposal are given priority. This permits the treatment of waterways and critical areas in advance of terracing. More rapid stabilization is obtained at greatly reduced cost and effort when effective treatment is given before the areas are subjected to large concentrations of water. Terracing operations generally are scheduled first on those fields having well-stabilized natural outlets. In this manner the system is developed progressively, with each phase being carried to completion before the next step is undertaken. The probability of having large areas of land inadequately terraced and maintained is thereby greatly reduced. Likewise the farmer is given an opportunity to adjust his farming operations more advantageously.

A more recent trend has been to place an increasing amount of emphasis on the desirability of planning water disposal on a unit watershed basis. This approach is not new since the principle has been used by engineers for years in developing plans for drainage improvements. In developing complete conservation plans for land under private ownership, the individual farm logically represents the smallest independent unit. However, from the standpoint of obtaining the most effective run-off control, an independent segment of a watershed constitutes the smallest area that should be considered. A condition frequently occurs where adjoining landowners have a common problem relative to water disposal. In some cases three or more farms may be involved.

By approaching the disposal problem on the unit-watershed basis, the most effective utilization of natural water courses is insured. Beyond that point complete conservation plans may be developed on the individual farms, since the framework for the overall water-disposal system has been provided for. Under a program of group action, designed to facilitate the development of farm plans in soil

FIG. 1
FLAT CREEK WATERSHED
ABOVE
GLADE SHOALS
HALL CO., GEORGIA

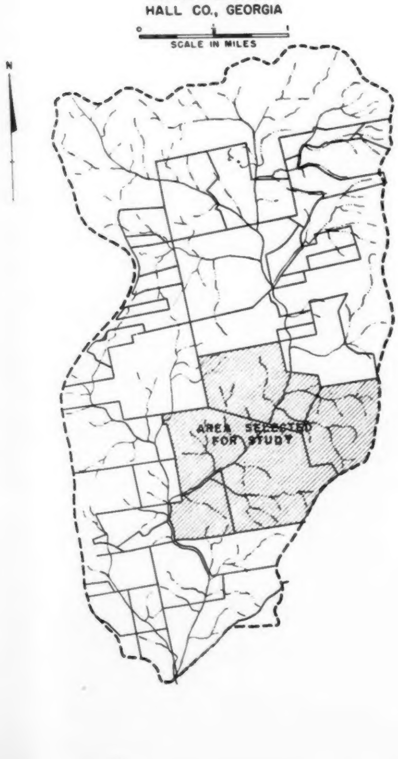
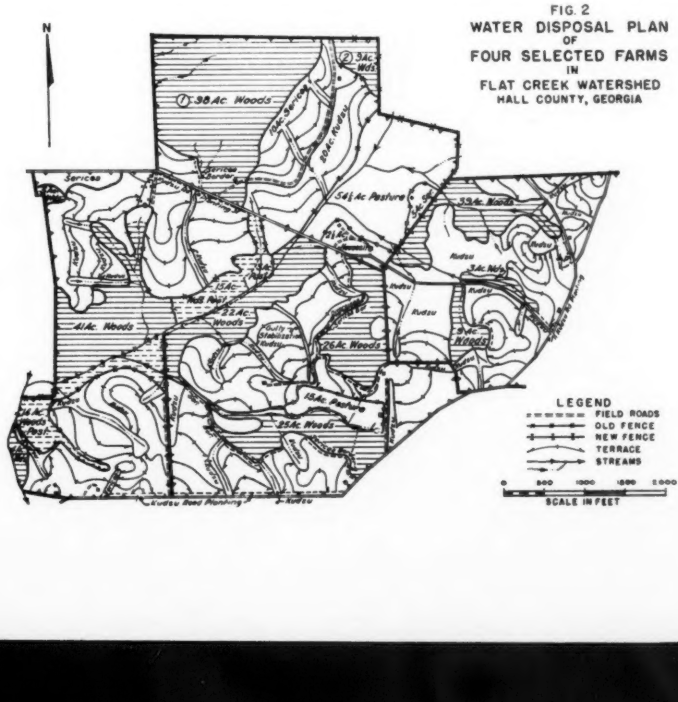


FIG. 2
WATER DISPOSAL PLAN
OF
FOUR SELECTED FARMS
IN
FLAT CREEK WATERSHED
HALL COUNTY, GEORGIA



conservations districts, conditions are most favorable for applying this principle. There is a need for a better understanding among landowners that natural drainage is not governed by farm boundaries. When a conservation program has been systematically planned and established in a community embracing a small watershed, maximum benefits accrue, not only to the individuals but to the community as a whole.

Directly associated with the transition in planning technique has been the realization that methods must be developed to expedite the ever-increasing volume of planning work in the district program. During the fall of 1940 a study[1] was started to determine the feasibility of making stereoscopic analyses as an initial step in the planning process. It was thought that the delineation of natural drainage features on the aerial photograph by means of the stereoscope would supply the technician with basic data that would be most helpful in planning water disposal. Furthermore, such a procedure would be well adapted to areas comprising unit watersheds.

AERIAL PHOTOGRAPHS WERE USED TO PERMIT STEREOSCOPIC EXAMINATION OF WATERSHED

The stereoscopic work was performed through the facilities of the Southeastern Regional Cartographic Division of SCS. A simple prismatic stereoscope, consisting of a dioptric stand equipped with arm bracket and two power plane convex lenses was used. This instrument is inexpensive, flexible, and simple to operate, as only minor adjustments are necessary to obtain maximum efficiency. For a man who is proficient in the operation of the stereoscope, a coverage of 50 sq mi per day is a reasonable output. An inexperienced man with normal aptitude for such work will require from 3 to 6 days training to develop average manipulative skill with this instrument.

Aerial photographs, consisting of consecutive flight sheets on the selected watershed were used to permit stereoscopic examination. Photographs at the scale of 1 in = 1,320 ft (4 in = 1 mi) were used in the actual delineation work. With this scale, approximately one square mile can be delineated from each fusion position. All streams, natural drainageways, and major field gullies were delineated on one set of prints. A photomosaic (scale, 4 in = 1 mi) of the watershed was then prepared on which farm boundaries were superimposed.

Fig. 1, which has been reproduced from the photomosaic, shows the outline of the watershed selected for the trial. This small watershed, comprising approximately 6,000 acres is located in Hall County, Ga., and is included in the Upper Chattahoochee Soil Conservation District. The heavy broken line bordering the drawing represents the limits of the watershed within which the natural drainage features have been delineated. The individual farm boundaries have been superimposed to show their relation to the natural drainage pattern. The shaded area near the lower left portion of the watershed represents the four farms on which a detailed field study was made to test the adequacy of the stereoscopic work.

In carrying out the field study, complete water-disposal plans were prepared for the four selected farms. Before going to the field an overlay map (scale, 8 in = 1 mi) was prepared for each farm showing farm boundaries, roads, buildings, and major existing land-use divisions. The drainage features, outlined in Fig. 1 for the four respective farms, were then transposed on the overlay maps. The value of the stereoscopic analysis as a basic step in planning is indicated clearly by results obtained from the field study. Fig. 2 represents the completed plans that were developed for the selected units. In preparing the plans, first consideration was given to the requirements for adequate control measures based on the existing physical conditions. At the same time an attempt was made to obtain a balance between the perennials recommended, so that they would fit in the farm economy.

ALL PHASES OF THE WATER-DISPOSAL PLAN HAVE BEEN INTEGRATED INTO A COORDINATED SYSTEM

An examination of Fig. 2 shows that consideration has been given to all phases of the water-disposal plan, which, together with major land-use changes, have been integrated into a coordinated system. It is revealing that in the development of this overall plan every one of the delineated drainageways was used. Likewise, where common drainage problems were found between adjacent landowners a proper solution readily was obtained.

These four farms comprise a total of 900 acres, of which approximately 550 acres may be classed as open land. The overall plans as shown in Fig. 2, were completed after 12 hr of field work. The efficiency with which the plans were developed is attributed to the fact that only one trip over the land was required. The additional basic data made available by the stereoscopic analysis permitted immediate decision as the various problems were confronted. In contrast, under present planning methods it is necessary for the planning technician to make a reconnaissance study of the farm, after which he may begin preparing a water-disposal and land-use plan.

Several apparent benefits are derived from the stereoscopic work, which may be summarized as follows:

First, an accurate base map is provided that identifies all major drainageways and field depressions. This basic information is secured with minimum effort and cost.

With these data at hand the technician in the field is able to plan the water-disposal system, together with major land-use changes, on his first trip over the land. At the same time, high-quality planning is insured, because the technician is guided by the natural pattern which is shown clearly.

Finally, this type of study appears to be adapted to a wide range of field conditions and to a variety of problems encountered in the programs dealing with conservation operations. Among the many uses to which the analysis may be applied the following are cited:

1 An effective approach to group action in the district program

2 Basic information for use in developing overall conservation plans for an action program on flood control and land utilization projects

3 Pertinent information applicable to preliminary investigations for drainage surveys

4 Providing, along with land-use capabilities, a sound basis for subdividing large tracts of land

5 A means whereby highway erosion-control plans may be directly correlated with water-disposal and land-use planning

6 A definite aid to water-disposal planning on the individual farm basis, since natural drainage features are identified and properly correlated with those on adjacent lands.

[1]Actively participating in the study with the author were T. M. Bailey, assistant chief, regional cartographic division, and J. D. Clement, associate agricultural engineer, Athens, Ga. Valuable assistance also was given by A. Carnes, chief, regional engineering division (Region 2); F. M. Orsini, chief, regional cartographic division; C. W. Chapman, associate agricultural engineer, Tifton, Ga.; C. H. Brand, work unit technician, Hall County, Ga., and others, all of the U. S. Soil Conservation Service.

Engineering Performances of a Multiple-Baffle Electric Sterilizer

By John E. Nicholas
MEMBER A.S.A.E.

STERILIZATION of dairy utensils is a prerequisite to sanitary milk production. This process must be carried out after each milking. Since heat is one of the most effective methods in rendering containers and equipment bacteriologically clean, the electric sterilizer offers a satisfactory answer to the dairyman's problem of sterilizing dairy utensils.

The role which bacterial contamination plays in the keeping quality of milk was studied by Russell[1]* in 1895. Two years later[2] while studying "tainted and defective milk" he emphasized the importance of having clean utensils for the production of clean milk. Harding and Prucha[3], in their work on the influence of visible dirt in relation to the bacterial contents of the milk, emphasized the importance of clean utensils. In 1920, Prucha, Harding, and Weeter[4] carried on extensive experiments showing the mechanical efficiency of rinsing and drying dairy utensils with regard to the germ content of milk. They recommended the use of large quantities of hot water at a temperature of 208 to 210 F (degrees Fahrenheit) for mechanical washing. Farrall and Regan[5], in 1929, studied electrically heated air sterilizers and came to the conclusion that hot moist air sterilization is equivalent to live steam in its bactericidal action. Dahlberg and Marquardt[6], in 1932, and Nicholas, Sperry, and Tomey[7], in 1933, verified these results with regard to comparability of live steam and dry heat sterilization.

In 1881 Koch and Wolffhügel[8] showed that hot air will completely destroy all living organisms if they are subjected to a temperature of 350 F for a period of 1½ hr. These same experimenters found that spore-free bacteria were destroyed by heating to a temperature of 212 F for 1½ hr. Ayers and Mudge[9] felt that the use of hot air at 350 F for 1½ hr would be highly impractical. As a result of their research, they concluded that the application of hot air at 230 F for 30 min would result in bacterial reduction sufficient for dairy purposes. Nicholas, Sperry, and Tomey[7] observed that "absolute sterility of dairy utensils is an unattainable goal for practical purposes, but utensils which are practically clean are frequently even sterile. The destruction of bacteria, except the high heat-resisting, spore-forming *Bacillus subtilis,* is satisfactorily accomplished after all the moisture from the wet utensils which have been placed in the sterilizer has evaporated" is the additional findings of the latter investigators.

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*Superscript figures indicate the references appended to this paper.

Fig. 1 Sterilizer loaded with 142.1 lb of utensils

Multiple-Baffle Sterilizer. The following discussion disclosed results of recent tests of a multiple-baffle sterilizer. The basic design of an apparatus is determined by the requirements which it must meet. In a confined space, heated or unheated, there is an air temperature difference at different heights. This difference may be considerable in a heated compartment if the air is not in motion, or if some provision is not made in the interior design to minimize it. The heat distribution becomes more uniform in a multiple-baffle sterilizer, since the hot air is diverted by baffles from the main heat-carrying channel to the regions or shelves where the utensils are placed or stored. This principle of air diversion and distribution by baffles is illustrated in the cross-sectioned portion of Fig. 2.

Fig. 1 illustrates an electrically heated sterilizer which was subjected to study and tests, loaded with different kinds of dairy utensils weighing 142.1 lb. Its total internal volume is 31 cu ft, and the usable volume 22 cu ft.

There are two utensil shelves. The two heating elements were strip heaters, 750-w each, located horizontally below the lowest shelf. The main heat-carrying channel was in the rear with the baffles located to divert the hot air to the utensil regions directly above the two shelves and below the ceiling.

When the sterilizer is loaded as shown in Fig. 1, in an environment of 75 F, the results of a heating and cooling process, as measured by 10 thermocouples are shown by the time-temperature graph in Fig. 2. Couples 1, 2, 3, 4, and 8 measured air temperatures, but only 1, 2, and 3, representing the maximum, minimum, and average air conditions, are charted. Couples 5, 6, 7, and 10 were attached to the utensils, and only 5, 6, and 10 also representing maximum, minimum, and average utensil temperatures, are charted.

Table 2 is the experimental data obtained from the 10 couples when the sterilizer is loaded as shown in Fig. 1. Table 1 designates the location of all the couples (some of which are spotted in the two views of Fig. 2) and gives the itemized weights of utensils.

TABLE 1. DESIGNATION AND LOCATION OF THE 10 THERMOCOUPLES AND A LIST OF THE DAIRY UTENSILS WITH THEIR WEIGHTS

Test No. 4 January 14, 1942

Sterilizer Load	Pounds
3 10-gal milk cans, bottom rack	75.3
1 milking machine pail, top rack	8.6
1 3-gal can, top rack	6.3
1 12-qt bucket, top rack	3.6
1 crate bottle, top rack	25.2
6 can lids, top rack	23.1
Total load	142.1

Location of Copper-constantin Thermocouples

No. 1—Air, center top of flue
2—Air, thermostat
3—Air, lower rack, center of back, near bottom
4—Air, lower rack, center front, at air entrance to heating elements (visible to strip heater)
5—Utensil, 10-gal milk can, lower rack, back right-hand corner
6—Utensil, milking machine pail, upper rack, left rear corner
7—Utensil, on inverted bottom of 10-gal can, center of bottom rack
8—Air, 1 in from couple No. 6
9—On bottle, top rack
10—Utensil, on pail top rack

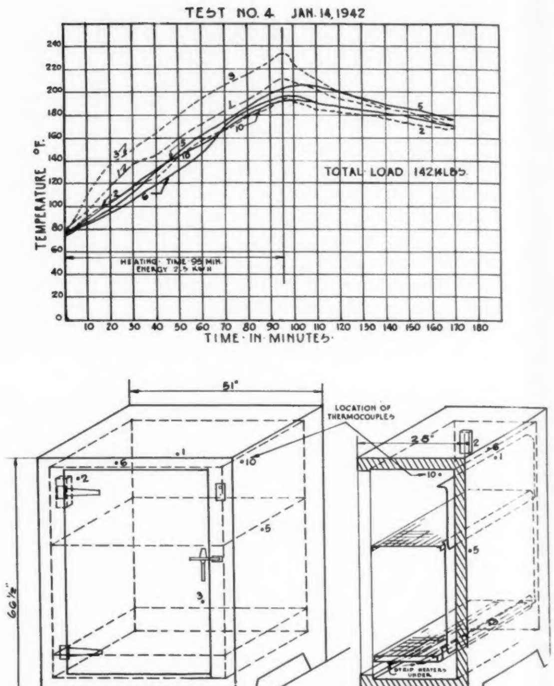

Fig. 2 The time-temperature chart at the top shows the rate of heating and cooling of inside air and utensils when the sterilizer was loaded as shown in Fig. 1. The drawing at the bottom left gives the outside dimensions of the cabinet. The approximate location of thermocouples is indicated in both the lower drawings. The lower side is cut away to show how the multiple baffling is arranged

The heating time was 95 min, and the energy consumed 2.3 kw-hr. Recording of the temperature continued for 75 min after heating stopped to determine how long the utensils remained above 180 F.

It is necessary to point out that thermocouple 4, Table 2, recorded a temperature of 350 F at the time heating stopped. This high temperature was obtained because of the proximity of the thermocouple and "direct seeing" of the strip heater. It therefore recorded part of the radiant energy which was not directly available to the utensil compartment.

The maximum utensil temperature was 205.8 F shown by couple 5, on a 10-gal can. This utensil was above 180 F for over 80 min. The minimum utensil temperature, that of a bottle on the top shelf, couple 9, was 190.8 F. This bottle was above 180 F for over 70 min. The maximum recorded difference in utensil temperature was 15 F. The maximum and minimum air temperatures were 227.5 F, couple 3, and 192.1 F, couple 8, a differential of 35.4 F.

When the sterilizer load was lighter than that shown in Fig. 1, the heating time was shorter. With the sterilizer completely empty of utensils and the thermostat set at 170 F, the heating time was less than 38 min.

The bacteriological efficiency studies with the sterilizer will be continued and will include the practical aspects as applied to the average dairy farm.

SUMMARY

1 This study reports the temperatures of dairy utensils as recorded by thermocouples attached to them during a sterilizing process.

2 The results of the tests with the sterilizer, designed to provide a more uniform heating of the utensils, show that when loaded as shown in Fig. 1, the maximum and minimum utensil temperatures were 205.8 and 190.8 F, a differential of 15 F.

3 The maximum and minimum air temperatures were 227.5 and 192.1 F, a differential of 35.4 F.

4 Higher or lower temperatures are possible by adjusting the thermostat.

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TABLE 2. THE TEMPERATURES ATTAINED AT 10 LOCATIONS BY AIR AND UTENSILS DURING A HEATING AND COOLING PROCESS IN A BAFFLE-TYPE ELECTRIC STERILIZER WHEN LOADED AS SHOWN IN FIG. 1

Test No. 4 Thermocouples, deg F January 14, 1942

Time, min	1	2	3	4	5	6	7	8	9	10	Kw-hr 1848.0
0	78.9	78.7	74.4	75.0	75.7	77.6	77.5	77.7	77.7	77.5	
10	96.9	86.2	112.8	181.0	85.5	84.7	84.5	92.0	86.0	88.0	
20	117.5	102.8	136.1	276.6	98.5	94.8	98.3	105.4	97.4	105.4	
30	138.3	118.6	150.6	284.4	115.2	106.5	112.7	119.3	110.4	119.4	
40	144.5	125.7	165.5	295.9	131.2	119.5	128.0	129.0	123.4	133.3	
50	160.4	144.6	181.8	311.1	148.4	133.5	144.4	145.6	138.0	146.5	
60	172.5	154.7	194.6	324.1	162.6	146.1	156.3	157.4	150.5	158.7	
70	182.4	167.8	206.2	340.8	174.5	173.3	169.5	170.1	163.5	169.1	
80	193.7	179.6	216.0	349.3	187.9	185.8	182.0	179.4	173.1	180.6	
90	207.2	187.0	227.5	350.2	198.2	192.3	192.7	189.8	182.6	188.9	
Heat off 95											
100	208.2	192.4	224.4	259.6	205.8	195.3	201.4	192.1	190.6	192.7	1850.3
110	202.2	184.8	211.0	218.9	205.0	190.8	199.1	191.1	190.8	191.0	
120	193.6	182.4	200.4	192.7	201.2	187.7	197.0	187.6	188.7	188.2	
130	190.5	180.9	193.9	183.4	195.8	185.4	193.9	185.2	186.4	185.5	
140	186.2	177.3	187.5	177.1	191.1	181.8	189.9	182.4	183.6	181.6	
150	182.8	172.5	182.2	170.7	186.8	178.5	186.6	180.2	180.8	178.5	
160	179.0	170.0	176.1	164.5	181.4	174.3	182.0	176.7	177.6	174.5	
170	176.1	168.0	171.3	160.4	177.1	171.3	177.9	174.0	174.7	171.1	

Heating time, 95 min. Total enery consumption, 2.3 kw-hr.

Spray Painting of Farm Buildings

By L. A. Buse

ASSOCIATE A.S.A.E.

LIKE many other insurance companies, our company acquired a large number of middle western farms as an aftermath of the inflationary period which followed the first World War. After acquiring the farms, the immediate problem was to rehabilitate them promptly so they could be restored to individual ownership. Fences had to be repaired, drainage systems cleaned, and the buildings repaired and painted. The repairs were a comparatively simple problem once an organization was built up to make them.

The painting problem was somewhat more difficult, however, as most of the buildings had not been painted for a number of years. This lack of protection had permitted the exposed surfaces to become checked, cracked, and extremely porous which resulted in a very shabby appearance. In spite of large amounts spent for repairs the restored buildings still looked shabby. Repainting was badly needed not only from a preservation standpoint but also to provide the attractive neatness which is a mark of character and good standing in most rural communities.

Spray painting was recommended to us by an equipment manufacturer. We tried it on a contract basis on a few jobs with unsatisfactory results. The finished product did not compare in quality or appearance with brush paint work. We did learn, however, that the painting could be done much faster, and that if a satisfactory spray paint system could be worked out, the time required for completing our painting program could be shortened by at least two years.

In order to make a careful investigation of the possibilities of spray painting, we designed and purchased a complete outfit. Farm men with some painting experience were hired to operate it. A factory representative spent several days with these men explaining the use of the equipment and experimenting with various paint. The experience of one of the federal land banks with spray painting was checked. Dr. F. L. Browne of the U.S.D.A. Forest Products Laboratory was called upon and furnished some very helpful suggestions. By the end of the first season the one experimental outfit operated by a three-man crew had painted 26 sets of buildings. Two coats of paint had been applied over 260,000 sq ft of surface area. From this trial we learned that the secret of succesful spray painting was good equipment operated by adequately trained men whose chief incentive was quality and not quantity.

We are now operating 12 spray paint outfits in three states. Each outfit includes a two-ton truck with a box body. This body is large enough to hold several hundred gallons of paint, supplies, and ladders, as well as four bunks for the crew members. A small, two-wheeled trailer carries the air-compressing equipment. Each crew has four men, two of which are gun operators and two are helpers. Three years of spray painting work have been completed with this equipment. Each year as the men have gained more experience their wages have been increased. These higher labor costs have not made for greater total costs, however. Instead, production has increased more rapidly than wages and our total cost per square has gone down each succeeding year.

After painting more than 1500 sets of farm buildings with spray equipment, we are thoroughly sold on the merit of the method. The quality of the resulting job is fully equal to and in many cases better than a brush job. Spraying is fast, thorough, and economical. A four-man crew using a two-gun outfit can apply two coats of paint on the average set of farm buildings (10,000 sq ft of surface area) in two and one-half 8-hr days. It would take a brush crew of four men at least ten days to do the same job.

Siding boards are usually cracked, checked, porous, and covered with dust. When paint is applied with a brush over such a surface, it bridges over most of these small crevices. As the paint film weathers it either cracks or wears away over the crevices first. Water, dirt, and moulds get into these unprotected places causing deterioration. When paint is sprayed on, it is driven into all but the smallest of these crevices giving much more thorough coverage regardless of the contour of the surface.

Spray guns made for commercial use have an adjustment by which the flow of paint through the nozzle can be controlled. By governing the flow of paint and the speed at which the gun is moved across the surface, the thickness of the resulting paint film can be controlled. This makes for better uniformity, quality, and economy.

The quality and type of paint used are important in either brush or spray application. In order to obtain the optimum film thickness (0.005 in) and eliminate loss of vehicle by excessive penetration, the paint should be designed to set up before too much of the oil soaks away from the pigment into the wood. First-coat sealers and primers put out by most manufacturers seal the surface and leave a good base for the second coat. Second-coat paints (particularly the whites) are usually slower drying and leave a flexible film which will chalk as it wears. Many red barn paints are now made to dry rapidly and to chalk slowly so that the same kind of paint can be used for both first and second coats. Both types of paint give satisfactory results.

In the Middle West the majority of farm buildings are not painted more than once in ten years. This is another reason why quality is important. The chalking type which contains a good proportion of pigment by volume has been found to be the most durable. A good way to determine quality is to check the ratio between the pigment and the non-volatile vehicle by volume.

I like to think of the composition of paint as comparable with that of concrete. The non-volatile vehicle (drying oils) in paint has a part similar to cement in concrete; the chemically active pigments (lead, zinc, titanium, etc.) compare with the sand; the inactive pigments or fillers are like the gravel, and the thinners (turpentine, mineral spirits, water, etc.) compare with water in concrete. Each ingredient contributes to the durability and strength of the finished product, and an excessive amount of any one of them tends to detract from or weaken the desired qualities.

When comparing costs of various methods of paint application, it is necessary to have a common denominator. Materials will run about the same for either brush or

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spray work. The labor cost has been considered to include the actual wages paid for man labor, social security, workman's compensation, unemployment assessments, and other payroll taxes, as well as a fair charge of upkeep and depreciation on equipment, operating supplies, and travel costs. No supervision, profits, or overhead charges have been included. These last three items are about the same for either the brush or spray method of application. Using this breakdown for arriving at costs, we have found that spray paint labor costs fifty per cent less than brush labor. Some writers have claimed a greater spread which is entirely possible. The amount of saving will depend largely upon the condition of the surface painted, the type of buildings, and the established wage rates within the given area.

In view of the advantages of spray painting, one wonders why it has not been more widely used. Certainly with some 60 to 75 per cent of the farm buildings in the country needing paint there is a definite field for a faster and more economical method. The benefits and savings of spray painting should be made available to the individual farmer. The plan that was used successfully in Knox County, Indiana, by Mr. H. S. Benson, county agent, could well be followed in other areas to introduce the method and get it started. By canvassing farm communities for jobs, rural paint contractors should be able to get enough work to keep several spray outfits busy for years. Certainly there is enough farm painting work to be done and the money to do it if the labor cost can be assured at a reasonable figure.

Discussion by H. S. Benson

County agricultural agent, Knox County, Indiana

IN the past painting upkeep has been neglected by farmers because of circumstances over which they have no control. The cost of painting by professional painters has been prohibitive and the price of farm commodities so low that the farmer's only recourse has been to do the work himself or with the aid of his farm help. Because of these things we found the farm buildings in Knox County (Indiana) were being neglected as our farmers were unable to get to the off-season job of painting, and since the work was little understood and not attractive, it was neglected.

Paint-up and clean-up campaigns having been popular in urban communities and the officers of our Farm Bureau knowing of these campaigns, it was decided to put on one of their own by organizing a yard and garden contest which, of course, involved the improvement of farm buildings. When the question was asked, "How are we going to paint-up when the high cost of materials and high labor wage of professional painters and low income caused by low prices of our commodities are so great that they are practically prohibitive?", the officers of the Knox County Farm Bureau sought to solve the problem by turning to modern business methods as employed by the automobile, furniture, and other industries in spray painting. They immediately found that equipment for spray painting was expensive. Then they took a lesson from the extension service which had organized orchard spray rings in many communities. They organized the Knox County Paint Spray Ring to aid in this yard and garden contest.

The purpose of this paint spray ring was to cooperate in the purchasing of paint, in securing a machine, and in employing labor to apply the paint. It offered many advantages in speed, cleanliness, economy of time, labor, ease of operation, excellence and variety of work, adaptability, and reduced the cost 50 per cent and the time of application 200 per cent. That gave the farm home owner the same opportunity had by those in the towns. Over the period since its organization in 1930 the ring has painted the property of a large number of its members and has made the countryside more beautiful and the value of its farm buildings greater and more permanent. The members of the Knox County Farm Bureau have always realized that paint will cut down depreciation of their buildings to a minimum, lower their overhead, and ultimately result in lower upkeep cost.

Paint manufacturers were asked to submit prices on paints of known quality. Ten manufacturers submitted prices. The successful company gave a low price on quality paint and furnished the compressor and engine for the painting. They also furnished an expert salesman to sell the paint to the membership, to aid them in selecting their colors and kinds of paint best suited to their needs, and to make collections for the paint.

When the paint ring was organized, a life membership fee of $2.50 was made, and this amount was used for the purchase of ladders, hose, and guns. The outfit consists of a $2\frac{1}{2}$-hp engine and air compressor mounted on the chassis of a Model T Ford car which makes a four-wheeled trailer on which it is moved from farm to farm.

One hundred feet of air hose and one hundred feet of paint hose are connected to the 10-gal paint container. In this container is set a 5-gal bucket of paint. By the use of the full length of the air and paint hose a work radius of 200 ft from the machine is obtained. The machine is operated under a pressure of about 35 to 40 lb. This pressure varies slightly, depending upon the height of the machine from the paint container.

The following is an itemized report of the work done:

Number of farmers for whom painting has been done	191
Number of buildings painted	659
Number of roofs painted	97
Gallons of paint used	5,713
Gallons of oil and turpentine used	989½
Cost of paint (first year only)	$2,286.85
Cost of labor (first year only)	$ 333.66
Profits of spray painting equipment	$ 406.40
Total cost	$5,645.39
Amount of gasoline used to operate machine, gal	1,818
Amount of oil used to operate machine, qt	25
Cost of gasoline and oil used	$ 352.14
Number of hours painted	3,176½
Expenses	$ 292.57
Membership fees collected (last four years)	$ 195.00
Balance on hand (1940)	$ 208.09

The spray painting outfit was turned over to the Knox County Farm Bureau Cooperative Association in the spring of 1941, and they report that 23 farmers have used approximately 950 gal of paint in 540 work hours.

The success of spray painting depends upon the operator. He must know farmers, be a good mechanic and an honest workman, and after getting the proper training and experience gives service to the people of the county. The painter will cover approximately 800 sq ft per hr, or based on a one-coat job, a coverage of 228.6 sq ft per gal. If the operator knows farm people and appreciates their wants, there will be very few complaints. With proper protection very little paint will be wasted, and very little will get on other parts of the buildings and equipment which is so aggravating to the average housewife and property owner. Our experience in Knox County leads us to recommend this plan very highly. We would recommend it one hundred per cent for farm homes, barns, garages, silos, granaries, corncribs, and other outbuildings. Also for automobiles, trucks, wagons, and farm machinery, and for porch and lawn furniture, or any other place it can be used in the open.

Terrace Grades on Shelby Soil as They Affect Soil and Water Losses

By A. W. Zingg
MEMBER A.S.A.E.

THE PURPOSE of this paper is to give a summary of an experiment designed to determine the most desirable channel grade for farm terraces on the Shelby soils, which are made up largely of till from the Kansan glaciation. Relatively friable and fertile coverings of surface soil at present vary from zero to extreme depths of 12 in, depending upon previous land use and the topography of the lands.

The experiment involved six terraces that were constructed in 1930. They were placed under measurement on January 1, 1932, with the use of Parshall rate measuring flumes and Ramser silt samplers. Records of rainfall, run-off, and soil loss from each of the terraces were continued through three crop-rotation cycles of corn, small grain, and meadow for the 9-yr period ending December 31, 1940. Data pertaining to the specifications of the six experimental terraces are given in Table 1.

Total rainfall for the 9-yr period of study was 252.75 in, giving a yearly average of 28.08 in. Rainfall records for the 51-yr period from 1890 through 1940 yield an average annual precipitation figure of 34.33 in for the location. An annual average deficiency of 6.25 in has therefore occurred during the 9-yr period of measurement of the terrace grade experiment.

All data pertaining to run-off from the terraces of various grades are presented in graphical form in the accompanying figure.

Paper presented December 2, 1941, at the fall meeting of the American Society of Agricultural Engineers at Chicago, Illinois. A contribution of the Soil and Water Conservation Division. This paper is a report of cooperative research in soil and water conservation investigations by the Missouri Agricultural Experiment Station and the Office of Research, Soil Conservation Service, U. S. Department of Agriculture. Author: Assistant agricultural engineer, Soil Conservation Service, U.S.D.A.

Total run-off increases in an approximately straight-line relationship, with increases in channel grade from zero to 8 in per 100-ft length of the terrace. This applies to all three crops of the rotation. Run-off occurred the following number of times on the terraces:

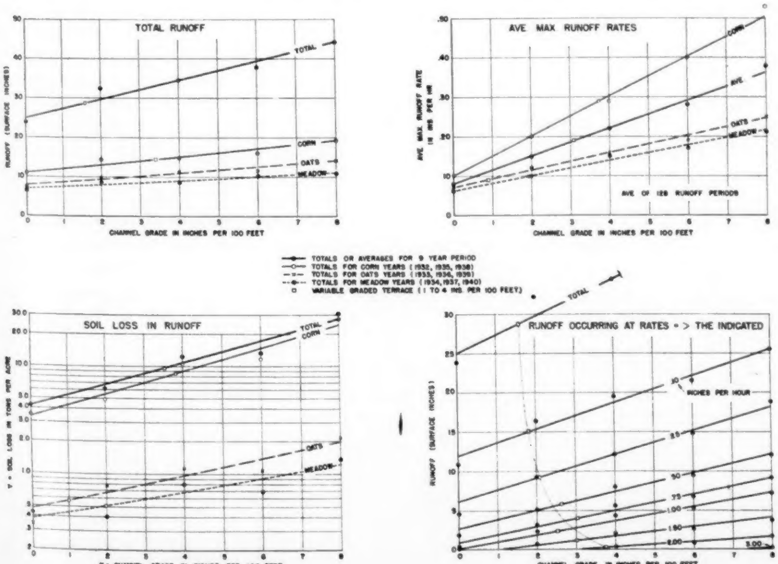
Symbol number	Grade per 100 ft, in	Number of run-off periods
5C	8	128
6C	6	115
7C	4	103
8C	2	103
9C	0	91
10C	1-4 (variable)	103

Obviously the depression storage of the channels varies with grade, and an increasing number of surface run-off periods from minor storms are retained entirely in the channels with decreases of grade. It is interesting to note that a similar rotation on plots farmed up and down the slope produced 135 run-off periods in the same 9-yr period.

A comparison of maximum run-off rates from each terrace, on the basis of 128 run-off periods, further shows that the average maximum run-off rate for all crops increases with terrace grade in an approximate straight-line relationship. The average maximum rate was five times greater on the 8-in grade than on the level terrace, when both were cropped to corn. The oats and meadow crops show lesser increases.

All run-off equal to, or greater in intensity than, given rates was further tabulated. The lower right-hand chart of the figure shows the results of such run-off tabulation for all terraces. It is readily apparent that amounts of run-off equal to, or greater than, all given rates, as well as total run-off, increase with the uniform grades studied. A study of the chart reveals that only a trace of run-off exceeding a rate of 1 in per hr occurred on the level terrace, while more than 7 in of run-off equal to, or greater than, a rate of 1 in per hr, occurred from the terrace with 8 in of fall per 100 ft. The latter terrace was also the only one to have run-off in excess of the rate of 3 in per hr.

The amounts of run-off equal to, or greater than, indicated intensities, from the variable graded terrace, are also plotted on the lower right-hand chart, in an attempt to



These charts constitute a summary of the terrace grade studies on the Shelby loam soil (1932 to 1940 inclusive) conducted at the Soil Conservation Experiment Station at Bethany, Mo., and reported in Mr. Zingg's paper

evaluate the variable-graded terrace in terms of those with uniform grades. A dotted line is drawn through an average of these plotted points. By reading equivalent values in terms of the terraces of uniform grade, it will be noted that total run-off from the variable-graded terraces is approximately equal to that from a 1.5-in uniform-graded terrace. Its performance approximates that of a 4-in uniform-graded terrace for run-off intensities equal to or greater than 2 in per hr. The variable-graded terrace is thus superior to a terrace of uniform grade, as it has the capacity to retain a relatively large amount of rainfall, and also to discharge run-off at relatively high rates when hydraulic efficiency is most needed.

There was no significant difference in the total time of run-off from various terraces for the 9-yr period. Run-off prevailed for 1,275 hr on the 8-in graded terrace, and for 1,223 hr on the level terrace. Lesser grades reduce the number of run-off periods, and compensatorily prolong the time of run-off, when the run-off does occur. It is of interest that precipitation occurred for 1,923 hr of the 9-yr period, or for an average of 35 min in each day of 24 hr.

Curves showing the total amounts of soil loss and integral amounts for individual crops are presented on the lower left-hand chart of the figure. Total soil loss for the 9-yr period is approximately represented by the equation, $\log y = (x + 6)/9.7$, where y = total soil loss in tons per acre, and x = grade of the terrace channel in inches per hundred feet. The logarithmic increase was slightly greater from the corn crop, and less for the small grain and meadow crops. Increasing the channel grade from level to 8 in per 100 ft approximately multiplied the total volume of soil loss in run-off by 7 for the corn, 4 for the small grain, and 3 for the meadow crops.

Data obtained from measurement of terraces of different channel grade clearly indicate that, from a theoretical consideration of soil and water losses, the level terrace is preferable. Practical considerations, however, almost eliminate the use of the level terrace on the Shelby soil. These additional factors governing the choice of terrace grades to use on the Shelby soils may be summarized as follows:

1 *Degree of erosion.* Lands from which a major portion of topsoil has already been lost, and where gully formation is active, require terraces with more grade than those that are non-eroded. Considerable rilling of soil between terraces may be anticipated until such time as cultural operations smooth out depressions, and vegetal cover is improved by soil treatment.

2 *Topography.* Irregular slopes, where terraces curve sharply on combinations of convex and concave topography, require relatively steep channel grades in comparison with uniform slopes.

3 *Cultural operations.* Planting, cultivation, and harvesting machinery cannot be used at the optimum time, where the terrace channels remain a series of ponds following a wet period. A level terrace on a Grundy ridge top, where the surface soil is 12 to 14 in in depth, has not appreciably postponed farming operations. Lesser surface soil depths, which include all the Shelby soils, have hindered cultural operations, where any portion of the terrace channel had a grade of less than 2 in per 100 ft. Operation of cultivation equipment on either eroded or irregular topography is accompanied by uneven depths of cut in moving the soil. For example, a plow or disk will move varying amounts of soil with changes in the physical condition of the soil along the length of the terrace. Their operation also tends to straighten curves along the length of the terrace. A consequent condition is the occurrence of high

TABLE 1. DATA PERTAINING TO TERRACES COMPRISING GRADE STUDY

Soil Conservation Experiment Station, Bethany, Missouri

Area symbol	Area, acres	Slope average, per cent	Slope length average, ft	Channel grade, in per 100 ft	Soil (type and depth) Shelby 9-12 in, per cent	Shelby 4-7 in, per cent	Colluvial material, per cent
5C	1.267	10.9	46.0	8	63	37	--
6C	1.255	11.0	45.6	6	44	50	6
7C	1.180	11.7	42.8	4	48	44	6
8C	1.274	10.8	46.2	2	55	22	23
9C	1.240	11.1	45.0	0	52	13	35
10C	1.170	11.8	42.5	1-4*	44	10	46

All terraces were contour cropped to a 3-yr rotation of corn, oats, and clover with timothy; 0-20-0 fertilizer was applied at the rate of 200 lb per acre, with each small grain seeding.

Length of terraces is 1,200 ft, and their vertical interval 5 ft.

*Variable graded terrace, with a fall of 1 in on the upper 300-ft length, plus 1 in for each added 300 ft of length.

points at locations where subsoil is exposed, or where terraces circumvent convex-shaped land areas. A channel grade of 2 in or more is, therefore, necessary to prevent excessive pondage and eliminate constant maintenance.

4 *Subsequent land use.* Terraces in bluegrass pastures and on lands to be cropped to alfalfa should have channel grades in excess of 2 in per 100 ft. Neither crop is tolerant of a prolonged saturated soil condition.

5 *Crop yields.* During the period of study, drought, location on the hillside with regard to wind direction, and insect damage have been of greater consequence than channel grade on the total yield of a terraced area. The grade of the terraces does not appear to affect the yield on the interterraced area to any appreciable extent on the Shelby soil. Yields in the bottom of the terrace channel have been, however, practically nothing where pondage has occurred.

The problem of how great the channel grade may be without gullying of the channel cannot be answered for all conditions. The 8-in graded terrace has shown no tendency toward gully formation in the 9-yr period. Likewise a non-experimental terrace of 1200-ft length, with a uniform channel grade of 10 in per 100 ft, has remained free from visible scouring.

Soil movement measured on other experimental terraced fields[1] provides a basis for estimating the soil moved to the terrace channels of the terrace grade experiment for the nine years' time. It is thus estimated that approximately 100 tons of soil per acre have been moved to the terrace channels of the terrace-grade experiment. Extrapolation of the previously given equation for soil loss with channel grade, yields a uniform grade of 13 in per 100 ft, as that required to remove an amount from the end of the terrace, that would have approximately equaled the amount eroded to the channel. The danger zone for channel scouring for conditions similar to those on the station is estimated to be in the neighborhood of 12 in per 100 ft. It would doubtless be less on shallower soils, or where the fertility level is less, than for the soil on which the experiment has been conducted. Practical field application of terraces should not require a terrace grade in excess of 6 in per 100 ft to meet any combination of conditions requiring a relatively steep grade. This grade may further be safely used on the Shelby soils.

SUMMARY

Study of terrace grades on the Shelby soil over a 9-yr period yields the following information:

1 Total run-off and the number of run-off periods increased with terrace channel grade, up to grades of 8 in per 100 ft.

2 Average maximum rates of run-off for 128 run-off periods increased with channel *(Continued on page 162)*

[1]Zingg, A. W. "Soil Movement Within the Surface Profile of Terraced Lands". AGRICULTURAL ENGINEERING, March 1942, vol. 23, no. 3.

Tilt Buckets for Measuring Run-off and Erosion

By C. N. Johnston
MEMBER A.S.A.E.

WHILE studying the run-off characteristics of a number of 50-ft square experimental burned and unburned range brush areas and small watersheds in Shasta County in northern California, it was found that the run-off records from the water-stage recorder sheets contained many hours of flow per week at rates far below the accepted safe range given in weir tables for the 90-deg V notch weirs used. When these data from the adjoining burned and unburned plots were tabulated, it was found that the run-off differences were small between adjoining burned and unburned plots. In order to determine whether these differences were real, it became necessary to construct a more accurate small water-flow metering device than had been provided.

The tilt bucket is a simple and cheap volumetric meter, and when equipped with a counter, a cumulative record of flow is obtained. A two-compartment bucket of 1 cu ft capacity on each side was built and installed in January 1940. This bucket is shown in isometric drawing in Fig. 1. Larger tilt buckets of 5 cu ft capacity per side were made for some small 2 or 3-acre ranges. A water-stage recorder is used to record the frequency of tips by the bucket with respect to time. The final arrangement had to be self-powered because the plots were unattended, except for weekly visits, and were too isolated to permit the use of electrical equipment.

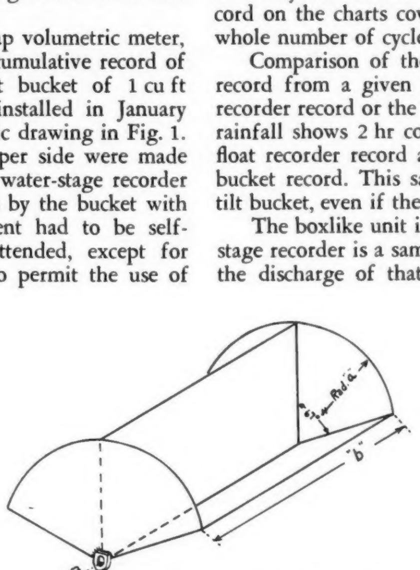
Two types of water-stage recorders are in use. In the first, the clockwork moved the pencil downward across the face of the paper-covered cylinder. This type of register was actuated by a simple ratchet wheel and chain drive (Fig. 2). Repeated tilts of the bucket were recorded on the sheet as successive steps horizontally around the cylinder without retracing its course.

The second type of recorder was made so the clockwork turned the paper-covered cylinder while the pencil was moved in a path normal to the time coordinate or up and down the sheet. Here the pencil had to be made to traverse the sheet of the recorder in integrated steps; first in one direction for the length of the sheet, then reversing its direction and returning to the starting point. The ratchet wheel alone would not give this motion, but it could be used to power a device that would. Of several such devices tried, the heart-shaped cam was most practical. The assembled drive for the second type of water-stage recorder is shown in Fig. 3.

It will be noted in Figs. 2 and 3 that a dashpot and dashpot arm have been added to the simple tilt bucket. The dashpot is necessary in the case of the larger tilt buckets, particularly where some 300 lb of water are discharged by dropping about a foot. Thirty S.A.E. oil was used in the dashpots, and about 1/16in clearance was maintained between piston and dashpot cylinder wall. It was found necessary to use 3-in diameter or larger dashpots on the larger buckets because with smaller cylinders during the partial vacuum of the upstroke of the dashpot piston, the oil column would be broken freeing the piston and ejecting the oil on top of the piston from the top of the pot. This oil loss ruined the action of the dashpot on the downstroke also. The Veeder counter was retained on all buckets to supply a weekly cumulative check of tilt cycles recorded by the pencil on the chart. The record on the charts covered half the number of tilts or the whole number of cycles of the tilt bucket.

Comparison of the time required to get the discharge record from a given area using the water-stage float and recorder record or the tilt bucket record for a week of heavy rainfall shows 2 hr consumed for the interpretation of the float recorder record and a minute at the most for the tilt bucket record. This saving in time justifies the use of the tilt bucket, even if the greater accuracy it allows is neglected.

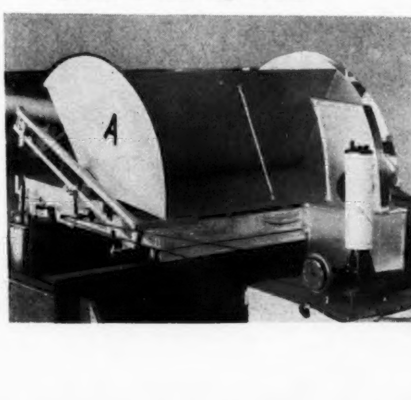
The boxlike unit in Fig. 2 shown just behind the water-stage recorder is a sampler that picks up one-twenty-fifth of the discharge of that side of the tilt bucket. It receives one-twenty-fifth of the discharge of the bucket because its slot-shaped opening facing the tilt bucket is one-twenty-fifth the width of the discharge edge it faces. It has ten ½-in holes in the bottom compartment, and the efflux from one of these is conducted off to a sample can from which a stirred sample is obtained each week. The sample contains only the finest suspended matter not caught in the field in the stilling box ahead of the tilt bucket. This sampler is especially effective because the discharge of the tilt bucket comes as a quick surge that

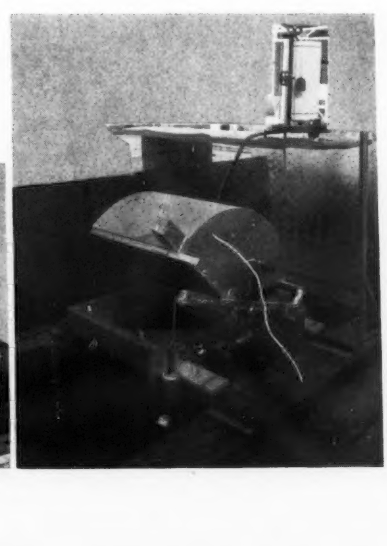


DIMENSIONS OF TILT BUCKET

Cu. ft. Capacity per side	Radius "a"	Face Length "b"
1	15"	20"
5	21"	48"

Fig. 1 (Above) Isometric drawing of tilt bucket. This bucket is made of 10-gage black iron, all-welded assembly. The bearing housings take commercial ball bearings and are welded to the sides of the bucket as shown • Fig. 2 (Below) Five-cubic-foot-volume tilt bucket set up in laboratory for calibration. Shows simple drive assembly for operation of water-stage recorder • Fig. 3 (Right) One-cubic-foot-volume tilt bucket in laboratory for calibration. Shows drive assembly with heart-shaped cam for operation of water-stage recorder





Article prepared especially for AGRICULTURAL ENGINEERING. Author: Assistant irrigation engineer, University of California.

sweeps the contents of the full side away quickly. For this reason, any fine material in suspension or settled in the water is stirred violently at the time of the tilt. Tests have shown that the ratio of silt to water in the sample caught is consistently close to that of the stream supplying the bucket and the aliquot retains uniform proportion to the contents of the tilt bucket at the instant of tilting throughout a season's run. The use of this divider provides an accurate proportioned sample of the very fine coloring matter that requires hours to settle out. A substantial weight of such material has been found to pass the settling boxes in the area under study.

Terrace Grades on Shelby Soil as They Affect Soil and Water Losses

(Continued from page 160)

grade. The average maximum was five times greater on the 8-in grade than on the level terrace.

3 All amounts of run-off, equal to or greater than selected intensities, as well as total run-off, increased with added increments of terrace grade.

4 The variable-graded terrace was superior to a terrace of uniform grade. It had the capacity to retain a relatively large amount of rainfall, and also to discharge run-off at relatively high rates when hydraulic efficiency was most needed.

5 There was no significant difference in the total time of run-off from terraces of various grade for the 9-yr period.

6 Total soil loss in run-off increased logarithmically with terrace grade. Increasing the channel grade from level to 8 in per 100 ft approximately multiplied the soil loss in run-off by 7 for the corn, 4 for the small grain, and 3 for the meadow crops.

7 Channel grades of less than 2 in per 100 ft were not practical on the Shelby soil. Level terraces were satisfactory only on Grundy silt loam ridge tops, where the direction and degree of slope were uniform and the depth of surface soil exceeded 12 in.

8 Channel grades up to 6 in per 100 ft may be safely used on the Shelby soil.

Discussion by Donald Christy

Agricultural engineer, A. and M. College of Texas

THE terrace gradient required is apparently dependent upon topography, slope, soil type, soil class, erosion, crops to be grown, terrace height, and terrace length. The human factor cannot be overlooked. I know men who make a practice of staking terraces with excess gradient. Their contention is that it is better to save some soil with terraces of excess grade than it is to use minimum grades and have ponding or broken terraces. The ponding and breakage discourage terracing by neighboring farmers and tenants.

The level terrace, especially the level closed-end terrace, is a product of and adapted to the semi-arid regions where moisture is the limiting factor of production. The level terrace, or the variable-graded terrace with the level portion, is used a great deal in the humid parts of the Southwest. However, I find considerable farmer reaction against the ponding thus caused.

The present trend is toward less and less gradient. A few years ago a 6-in gradient was considered the maximum desirable. The present maximum being recommended for the gentle slopes of the Southwest is 3 in.

An analysis of the hydrographs and the soil losses of a number of terraces of the southwestern erosion experiment stations indicates that there is little or no advantage in favor of the variable-graded terrace of 0 to 3 in over the 3-in uniform-graded terrace. There is little or no significant difference in soil loss or maximum rates of run-off. There is a slight reduction in total run-off, but the ponding in the level portions of the terrace more than offset the value of the water saved.

There is one main advantage of the variable-graded terrace. The first terrace of a long variable-graded terrace system on a gently rolling field is not as likely to come out on top of the hill. We have found that a judicious use of both the variable-graded and the uniform-graded terraces in the same field may help eliminate point rows between terraces. The county agent and the vocational agriculture teacher find it easier to teach farmers how to use the rod if the uniform gradient is used. This is important if the farmer must help stake the terraces.

The most important phase of terrace gradient is to be sure that it does exist to and through to the outlet. A survey of all new terrace breakage led to the conclusion that most breaks were due to incomplete outlets. Terraces built up to a fence were not opened to the pasture or to the outlet for which they were intended. The result was a breakage.

Mr. Zingg's conclusions as to the effect of grade on soil loss is very similar to ours. Our total run-off analysis does not show a definite trend, especially when the long-time results are studied. The maximum rate of run-off increases with grade, especially with the maximum grade of the terrace. Our conclusions as to recommended practice concur in principle with the discussions of Mr. Zingg, but the gradient figures are about one-half as great.


These two identical outfits—Case tractor and four-row planter—plant 40 acres of corn per day. It is equipment like this that greatly increases farm labor efficiency and enables farmers to comply with the heavy demands of the food-for-freedom program

Harvesting Cornstalks for Industrial Use

By J. B. Davidson, C. K. Shedd, and E. V. Collins

FELLOW (CHARTER) A.S.A.E. FELLOW A.S.A.E. MEMBER A.S.A.E.

IN A book published in 1837, Emmanuel Pallas[1], a Frenchman, suggested the use of cornstalks for the making of paper. In 1911 the U. S. Department of Agriculture published a report[2], a part of which was printed on paper made from cornstalks, dealing with experiments in making paper from farm wastes. In this publication it was stated that cornstalks were an inviting source of raw material for paper making and were more satisfactory than most of the other wastes tried out. At the time of this report, it appeared that cornstalks might be used extensively as a source of pulp for the making of paper and other similar materials within a comparatively short time.

Interest in cornstalks as a source of raw cellulose has continued through the years and some progress has been made. At least one factory was built to use cornstalks as a raw material for the manufacture of wallboard; but it is to be admitted that progress in utilization has not been rapid. The development of many new products from raw materials of the same general class as cornstalks has not stimulated the use of the latter. There has been much discussion but little utilization. Millions of tons of cornstalks await harvesting. All this remains true in spite of full assurance from those in charge of certain chemical industries that they would be glad to use cornstalks, if the quality was satisfactory and the cost at the factory was such as to make it an inviting raw material in competition with other materials.

It would be a most valuable contribution to the problem of harvesting if a number of individuals interested in the utilization of cornstalks would make a careful study and report standards of quality required of cornstalks, for various uses, and also report the nature of the competition that they must meet from other materials. We need an answer to the question, how much per ton must cornstalks sell for, delivered at the factory, to compete with other sources of cellulosic material.

A paper presented December 1, 1941, at the fall meeting of the American Society of Agricultural Engineers at Chicago, Ill. A contribution of the Power and Machinery Division. Authors: Respectively, head, agricultural engineering department, Iowa State College; agricultural engineer, Bureau of Agricultural Chemistry and Engineering, U. S. Department of Agriculture; research professor of agricultural engineering, Iowa Agricultural Experiment Station.

[1]Pallas, Emmanuel. Recherches, Histriques chimiques agricules et industrielles sur Mais. Paris, 1837.

[2]Brand, Charles J. Crop plants for paper making. Cir. 82, Bur. Pt. Indus., U. S. Dept. of Agr., 1911.

Time of Harvesting. The harvesting of cornstalks must be related to the harvesting of the grain, or the picking of corn as the operation is called. It has been customary to think of cornstalk harvesting as an operation to be carried out after the corn has been picked.

The harvesting of cornstalks as a subsequent operation has been practiced in a small way for many years with the conventional machines found upon the farm. The stalks have been loosened by breaking with a harrow or a dragbar, such as a railroad rail, or cut with a stalk shaver, then raked into windrows and gathered with a sweep rake to a stationary baler. Since the development of the windrow pick-up baler, this machine has been tried for baling the stalks from the windrow.

Cost of Harvesting Cornstalks. Harvesting practices have been studied by the Iowa Agricultural Experiment Station and reported in Bulletin 274. The best labor economy of 13 years ago was obtained by a combined harvesting outfit (see accompanying illustration), consisting of a mower, a hay loader, and a threader baler with automatic feed driven from a power take-off. Continuous operation by two men was possible. The cost of harvesting cornstalks with this outfit, under favorable conditions, was as follows:

Rate of harvesting—2 acres per hour	
Yield—2/3 tons per acre	
Cornstalks harvested 1 1/3 tons per hour	
Cost of operation per hour—	
Labor, 1 man at 60c, 1 man at 40c	$1.00
Power	1.25
Wire	.45
Machinery	.50
Cost per hour (1 1/3 tons)	$3.20
Cost per ton	$2.40

Since these studies were made, the windrow pick-up baler has been developed, and during the past year the Iowa station has reviewed the method of harvesting with this machine. Three methods of breaking and loosening the stalks were tried out, namely, (1) low cutting knives attached to the tractor pulling the side-delivery rake putting the stalks into a windrow, (2) harrowing down with smoothing harrow, twice over, and (3) cutting stalks with conventional tractor stalk cutter drawn ahead of the side-delivery rake.

In a field yielding 2/3 ton of stalks per acre, this two-man outfit harvested and put into bales 1 1/3 tons of cornstalks per hour

The following observations were made in May 1941 with an outfit consisting of a baler with two men and one man on the tractor, the cornstalks being dry and badly weathered:

	Method of loosening		
	Low knives	Harrow	Stalk cutter
Labor of cutting and raking, man-hours per acre	.27	.56	.25
Labor of baling	1.83	1.15	.90
Labor, total per acre	2.10	1.71	1.15
Yield, tons per acre	.85	.34	.33
Labor per ton, man-hours	2.47	5.04	3.50

The low cutting knife used in method 1 pulled out a good many corn roots and accounts in part for the higher yield. A larger yield of stalks, however, was harvested.

In November 1940 one of the authors visited the sections in northeastern Iowa and western Illinois where cornstalks were being harvested. It was found that harvesting was carried on by contractors who had balers. Of four contractors visited, none were using pick-up balers, but they were bringing the stalks to a moveable baler drawn to convenient locations in the fields. In most instances the sweep rake was used to bring the stalks to the baler. The labor duty as near as could be determined from the statements and records of the contractors, varied from 3.6 to over 9 man-hours per ton. It was observed that there was much hard work of a very disagreeable nature connected with the harvesting of cornstalks by this method. The weather interfered greatly with the work, often stopping it entirely for weeks. The material in general contained too much dirt to be wholly satisfactory.

Harvesting Stalks with the Grain. A study of the methods used in harvesting cornstalks after the corn has been picked rather definitely points to the conclusion that, if the desired quality of raw material is to be produced, the stalks must be harvested at the time the ears are harvested, and kept off the ground as far as practicable. Stalks beaten into the ground cannot ever be wholly satisfactory. The harvesting of stalks at corn picking time calls for new techniques and new equipment. Stalks at the time ears are ready for picking usually contain much moisture, so a curing problem is introduced.

Cornstalks of various varieties harvested during the corn picking season of 1940 contained from 58.7 per cent of water on October 23 to 40 per cent as a high on December 12 and a low of 28 per cent for one variety. The leaves and husks, however, dried out quickly, containing from 7 to 14 per cent of water on October 23.

Cornstalks contain many soft parts which are of little value in the making of pulp, because they are washed out as the firmer portions are processed. In the ultimate solution of cornstalk harvesting they should be partially processed at the farm and only the useful portions baled and shipped. A weight analysis of a few stalks, air-dry, windblown and harvested March 8, 1941, gave the following results:

Ribs of leaves	0.07 lb	2 per cent
Remnant of leaves	.1	3
Sheaths	.58	16
Husks	.65	18
Pith	.74	21
Fiber from stalks	1.48	41
Total	3.62	100

Finally, if cornstalks are ever to be in demand by manufacturers with the present competition of raw materials from other sources, the process of harvesting must be fully mechanized and the raw material supplied not only at an inviting figure but with a satisfactory return to the farmer. As suggested, it would be of much interest in this connection to have a competent chemist familiar with the use of the raw materials, of which cornstalks are representative, compare their value and current costs.

With the information available, the harvesting of corn stalks appears to be not only an inviting field for investigation but also the key to their use for industrial purposes. The four point program for the harvesting of cornstalks would seem to include the following objectives:

1 Clean material
2 A technique for curing or drying
3 Methods of semiprocessing, thus keeping the more edible portions on the farm
4 A raw material which will undersell other competing materials at the factory.

Use of Cornstalks on the Farm. In many instances not enough straw is now produced on some farms for bedding and litter. Experiments indicate that a forage harvester can be used to harvest and process cornstalks for such uses. A test of a small one-row forage harvester indicated that two men could harvest and process cornstalks yielding 0.92 tons per acre at the rate of 0.9 acres per hour.

The Profit Aspect of Industrial Use of Farm Residues

By Frank G. Kranick
FELLOW A.S.A.E.

IN considering the subject of industrial utilization of straw and cornstalks, it must be remembered that the farmer's objective is to grow his crops for feed or to sell for cash.

On one farm a test run was made which gave the following information. In a field where grain was harvested by a combine, the stubble was cut with a 12-ft windrower. This field of 47 acres was baled in 47 hr and produced 1121 bales of 60 lb each, that is, 23.8 bales per acre, or 1431 lb of straw. This is a yield of 0.72 tons per acre, and is a low yield of straw. This result isn't very encouraging from the farmer's point of view, that is, with respect to income, considering the amount of work and interest on equipment. The straw in this case was not a waste—it was an essential part of his crop, which he used for bedding for his herd of dairy cows. *(Continued on page 166)*

Paper presented December 1, 1941, at the fall meeting of the American Society of Agricultural Engineers at Chicago, Ill. A contribution of the Power and Machinery Division. Author: Research engineer, J. I. Case Co.

The tractor and pickup baler has become one of the most important equipment combinations found on American farms

Baling Straw with the Pickup Baler

By A. J. Schwantes

FELLOW A.S.A.E.

IN Minnesota very little straw is baled simultaneously with threshing. In the grain-growing areas of the western and northwestern part of the state, considerable straw is baled from the stack with stationary balers, when there is a price incentive. Recently, however, the practice of baling straw with the pickup baler following the combine has begun. This occurs principally in livestock areas, and almost invariably the reason for baling is to facilitate handling, storing, and using the straw, rather than selling it for shipment. A certain amount changes hands among farmers in the community.

Many owners of baling machines are farmers who bale their own straw and hay and do custom work for their neighbors as well. Some do very little custom work, while others use their machines only to bale for others. Some own more than one baler, either a stationary baler and a pickup, or two pickup balers.

Where narrow-cut combines are used, two or more windrows are laid together to save time and travel with the baler. Usually the bales are dropped on the ground as they are made by the baler and are later picked up, placed on a truck or wagon rack, and hauled to storage. One of the cooperators interviewed pulled a trailer behind the baler on which the bales were piled as they came from the baler. One man was on the trailer. While this practice requires a comparatively large crew, it obviously results in a saving of labor.

On farms where these data were obtained, oats, barley, wheat, rye, and flax straw were baled. The average yield was 0.52 tons per acre. The average weight per bale was 76.5 lb, and the density was 12.4 lb per cu ft.

Baling costs with the pickup baler are shown in Table 1. Data on the cost of use of baler and auxiliary engine, cost of baling wire, and labor requirements were obtained from twelve operators, some of whom owned and operated two balers. As might be expected, there was a large variation

TABLE 1. COST OF BALING STRAW WITH PICKUP BALER
(November 1941)

Item		Cost per ton
Baler (9 machines)		$0.330
Tractor	$\begin{pmatrix} 40.8c \\ 50.8c \end{pmatrix}$ 45.8c per hour x 0.5	0.229
Auxiliary engine operation	$\begin{pmatrix} 13c \text{ fuel} \\ 2.4c \text{ lub.} \end{pmatrix}$ 15.4c x 0.5	0.077
Baling wire	$\left(\frac{2000}{76.5} \times \frac{\$1.92}{125}\right)$ 26.2 x 0.015	0.401
Labor	(3.55 x 0.5) 1.77 x 0.30	0.531
Total		$1.568
Owner's estimate of baling costs, including power, labor, and machine costs and wire, averaged per ton		$1.73
Charges for custom work—per bale		8 to 10c
per ton		$2.50 to 3.00

in the annual use of balers. Most of them are used for hay and flax straw, as well as straw of the cereal crops. Thus the work is spread over a long season permitting a high annual machine use, especially if the owner wishes and has opportunity to do custom work. There was a tendency on the part of the owners to estimate the life of the machine somewhat in proportion to the annual use. These ranged from 3 to 15 years. The average of those interviewed was 971 tons baled per year which obviously puts them in the class of commercial operators.

The annual repair cost varied from very little in the case of some new machines to $50.00 and $75.00 for some of the older machines. Since a number of the machines were new, the annual repair cost was assumed to be $44.00 which was the average for those machines that had been in use for some time. Common repair items were welding and replacing broken blocks and belts.

A variety of tractor sizes were used to pull the baler. Data on the cost of tractor use for this purpose were obtained from a report on tractor costs issued by University of Minnesota, Department of Agriculture, in April 1941[1].

The average cost per hour of operating one-plow tractors was 40.8c and of two-plow tractors, 50.8c. While the one-plow tractor has ample capacity to pull the baler, larger tractors were actually used by many farmers. The charge assigned for the use of the tractor was, therefore, the average of these two, or 45.8c per hr. The charges of 13c per hr for fuel and 2.4c for lubricants for the auxiliary engine were taken from the same source and are the cost of those items for the one-plow tractors.

The average cost of baling wire was $1.92 per bundle, and the cost of wire per bale was 1.5c. No galvanized wire was used, and the usual length was 9½ ft.

TABLE 2. STRAW BALING COSTS AND PRACTICES WITH PICKUP BALER
(November 1941)

Cost of baling, per ton	
Computed	$1.57
Owner's estimate	1.73
Charge for custom work	2.62
Data on baling	
Tons per acre (yield)	0.52
Tons per hour (rate of baling)	2.02
Size of crew	3.55
Man-hours per ton	1.77
Data on hauling	
Distance, miles	¼ to 10
Tons per hour	2.10
Number of men in crew	2.80
Man-hours per ton	1.34
Truck-hours per ton	0.54
Data on bales	
Weight, lb	76.5
Density, lb per cu ft	12.4
Moisture content, per cent (11.75 - 17.15)	14.0

A summary of costs and practices is shown in Table 2. Hauling practices and distances varied considerably. The usual practice was to drop the bales on the ground, to be picked up later and loaded, usually on a truck, for hauling to storage or market. The crew for hauling varied from one to four men. Usually three men and a truck were considered necessary to haul at the same rate as baling was done. On many farms the loading on the truck or wagon was accomplished by two men with forks working together, lifting the same bale.

Most farmers try to get the straw under shelter as soon as possible after baling. One of our cooperators reported that his straw had gotten soaked with rain while still in the field after baling. The bales were placed on end in the field, in which position they *(Continued on page 167)*

Paper presented December 1, 1941, at the fall meeting of the American Society of Agricultural Engineers at Chicago, Ill. A contribution of the Power and Machinery Division. Author: Head, agricultural engineering department, University of Minnesota.

[1]Pond, G. A. and Schwantes, A. J., "Tractor Costs and Rates of Performance", Division of Agricultural Economics, Mimeographed Report No. 122.

Equipment Combinations for Harvesting Cornstalks

By Arnold P. Yerkes
MEMBER A.S.A.E.

ONE experiment which our company carried out during the past season was in saving straw behind a combine through the use of a tractor mower and pickup baler. As no satisfactory field of wheat could be located a barley field near Woodstock, Illinois, was selected, in which was a considerable growth of grass ranging from 6 to 10 in in height.

The mower used was a 7-ft trailer type equipped with a windrower, and the pickup baler was attached to the mower in much the same manner that a second mower would be hitched.

The combine cut a 6-ft swath and placed the straw in a windrow. It left the stubble about 12 in high. The mower was set to cut 3 or 4 in above the ground, and it did a remarkably good job of making a windrow of the stubble it was cutting and of the straw left by the combine.

There had been some doubt as to whether the windrower would handle the cut stubble, or whether the straight pieces of straw would drop between the steel strips and be lost. However, under these particular conditions, due to the growth of weeds and grass cut with the stubble, there was practically no loss of this kind.

The pickup baler did an excellent job of gathering up the entire windrow and of baling it. There was some loss from "backfeeding," but this could be easily overcome.

It was the opinion of everyone present at this test that this combination of machines offered a very effective method of handling the straw behind the combine, and that it would be about as economical as any method yet devised.

Another experiment which the company carried out involved gathering and baling corn fodder from a field which had been harvested with a mechanical picker. In this case, an experimental forage harvester was used with a pickup baler hitched directly behind it, the latter machine having its pickup attachment removed and a sort of hopper or feed trough placed just above the feed chamber and directly under the discharge of the forage harvester elevator.

The test was carried out on a farm in southern Wisconsin, and the fodder had been considerably smaller than that commonly found in the corn belt proper. Most of the stalks had ranged from 6 to 8 ft in height, but care had been exercised in operating the picker to avoid having wheels run directly over the rows so that the fodder had a higher percentage of stalks still standing with half their lengths erect than is often found.

The forage harvester was a 42-in cut and hence could take but one row at a time. Its cutter bar was equipped with two grain lifter guards, such as are frequently used on combines, one running on each side of the row. These guards lifted a great many pieces of stalks from the ground and made them pass over the cutter bar and also saved many of the top halves of stalks which were hanging loosely from upright stubs.

At first the regular cutter head used for cutting grass or corn for silage was used. This did a good job of cutting up the fodder, but left many short cylindrical pieces which, after being delivered into the feed chamber of the baler, tended to roll to the bottom and made a very uneven bale.

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The cutter head was then replaced by another one which did not cut, but tended to shred the fodder. This produced a satisfactory bale, but the amount of fodder which could be cut and baled per hour with this four-man outfit, taking only one row, would probably be too small, even where the yield was heavy, to make it economical.

Another experiment which the company undertook, but which it has been unable to complete to date due to the exceptionally rainy weather during the latter part of 1941, was the cutting of a corn crop with a binder, and shocking it, with the intention of running this fodder after it was thoroughly dry through a husker-shredder, delivering the shredded fodder directly into a baler.

This method appears to have some advantages over any method which is intended to gather the fodder behind a picker and bale it, at least in case this work is done immediately after picking. At that time the moisture content of the stalks is relatively high, and it is believed there would be considerable molding in the bales which might lessen its value for industrial use. At any rate, the expense of handling and shipping this added weight would be considerable.

With ordinary corn belt fall weather, it is believed the fodder in shocks would dry out much more thoroughly, a much higher percentage of it could be saved, and there would probably be less dirt mixed with it than if the stalks were gathered behind a picker.

A considerable acreage was cut with a corn binder and shocked several weeks ago, but up to this time the weather has been such that the fodder has not been dry enough to shred and bale.

The Profit Aspect of Farm Residues

(Continued from page 164)

The strawboard manufacturer wants to be insured of an adequate supply of straw so he can be sure to get a sufficient amount during the summer and fall to run his factory throughout the year. He wants to purchase it at a price that will enable him to compete with other products. This calls for a fixed yield with short hauls to the factory and for a constant supply year after year. The farmer can't count on fixed yields year after year. Weather, pests, and other factors influence production of agricultural products.

The farmer wants heavy yields of grain and short straw to reduce hazards of loss and to get best results and lowest production costs. The strawboard mill needs lots of clean, long straw, and there is a maximum price it can pay for it. One of the problems is that the strawboard mills are in Illinois, Indiana, Ohio, etc., where the straw is useful to the farmer. In the west, in such states as Nebraska, Kansas, South Dakota, and North Dakota, they have straw to burn, but no mills to use it.

The farmer's problem in connection with the utilization of farm residues, is not unlike the general problem in agricultural production, that is, to lower the cost per unit of all his products. It calls for the diligent and economic use of power machinery and time. This is the crux of the whole agricultural problem. The farmer will do the job that nets him the greatest profit with the least effort. All this is a challenge to the agricultural engineer.

Field Choppers for Harvesting Residues

By F. D. Jones
ASSOCIATE A.S.A.E.

AS FIELD hay cutters are going to become more popular equipment with farmers, especially in the Middle West, the possibilities of their use for harvesting agricultural residues, or more specifically, straw and cornstalks, are interesting.

Ever since the introduction of the combine into the more humid areas of the Middle West, the harvesting of straw has been an important consideration. In fact, the lack of solution to this problem has materially delayed the introduction of the combine into many sections of the country.

The field cutter seems to have good possibilities for solving this problem, and, besides this, it may later become the means of reducing the cost of the field operations involved in the harvesting of straw and cornstalks for processing in industrial plants. This field cost of harvesting now seems to be one of the limiting factors in the marketing of straw and cornstalks for industrial uses.

For use as feed and bedding around the farm, chopped straw seems to have all the properties of the unchopped material, besides the advantages of easier handling and decrease in storage space. Some claim it is better than whole straw in the manure, as it makes it easier to handle and has more capacity for absorption than unchopped straw.

We believe that straw can be chopped in the field and loaded and put into storage cheaper by the use of the field chopper and blower than by any other method. This method also has the advantage that no additional equipment is needed; the most that would be required would be an attachment to adapt the cutter to picking up dry material and cutting it to the right length, and possibly some boards added to the wagon or truck rack to adapt them to handling this kind of material. Many users would no doubt already have this equipment for handling dry hay. After interviewing users who have cut straw in the field, we believe the cost would run in the neighborhood of $1.20 a ton for chopping, hauling, and blowing the material into the barn. This figure may vary due to different labor costs, variations in time the machine is used, cost of tractor power, and so on.

The field chopping of cornstalks may have possibilities. We believe the costs would be more than for straw on account of the difficulties attached to getting the whole stalks into the cutter and the consequent decrease in the output of the cutter.

In order to market the chopped material, some method would have to be devised for shipping it. The material would have to be cut considerably longer than is now customary, in order to bale it with the balers now on the market. However, we can see no big advantage in both chopping and baling the material for industrial uses. There might be a slight decrease in baling costs, but we do not believe this would be justified.

There is a possibility that chopped material could be economically trucked to a processing plant loose in a truck equipped with a large rack, if the haul is not too long. The material could be discharged from the chopper directly into the truck and hauled to the plant with no expense for loading. Unloading could be done with blowers and would be much faster and cheaper than handling bales. I am of the opinion, however, that so much of it would have to be transported so far that the transportation of the chopped materials would present a very difficult problem to solve before this method could be used.

In visiting some of these straw and cornstalk consuming plants, for making paper and insulating board, we find them equipped and arranged for using baled material only. The reason for this is that baled material is easily handled for shipment and can be stored in large piles in the open until it is needed for processing. The cost of shelter for the material is thus eliminated, and, as large quantities of the material must be stored from one season to the next, this might be a large item.

Chopped material would have to be put into some sort of large containers for storage until it is ready for use, and handling equipment provided for taking the chopped material from the storage to the processing plant. Industrial plant operators interviewed in regard to the possibilities of this plan were not at all enthusiastic about it. However, if we are faced with a shortage of baling wire, labor, and other essentials, something on the order of this plan might have to be worked out. Incidentally, some of the bale ties are reworked by these plants and reused. This of course has its limitations.

At present, the plants in our section of the country are paying $7.00 per ton for baled straw delivered at their plant and $8.00 per ton for cornstalks. The price is the same for combined and stacked straw and whole and shredded cornstalks. They say they are getting all the raw materials they need.

Another speaker on this program mentioned that the raw material now sold to these plants contains considerable trash and dirt. Possibly the methods used to harvest these materials could be improved which would eliminate this and a higher price could be paid for them.

We find some flax straw is being baled in our section of the country. This is shipped to a processing plant where it is decorticated and the fiber rebaled and shipped to the Carolinas for processing into cigarette paper. From the brief investigation we made of this product, we found out that chopping would cut the fibers too short and the chopped material could not be used for this kind of product.

In summarizing, I believe that the use of chopped residue materials will increase on the farms, but there are some very serious problems to work out before they could be transported, stored, and handled by industrial plants.

Paper presented December 1, 1941, at the fall meeting of the American Society of Agricultural Engineers at Chicago, Ill. A contribution of the Power and Machinery Division. Author: Engineer, Dain Mfg. Co.

Baling Straw with the Pickup Baler

(Continued from page 165)

dried out so they could be safely stored in a barn. The moisture content of a sample taken from one of those bales after it had been stored in the barn for some time was 14.8 per cent. The average moisture content of nine samples taken from as many lots in storage was 14.0 per cent with a range of 11.75 to 17.15 per cent. A sample of flax straw recently baled from a stack contained 30.3 per cent of moisture.

Efficiency of Combine at Various Stubble Heights

By E. A. Silver

MEMBER A.S.A.E.

AT THE request of the A.S.A.E. Committee on Agricultural Residues, the Ohio Agricultural Experiment Station and the U. S. Bureau of Agricultural Chemistry and Engineering conducted a study of combining wheat at various heights of stubble, the purpose of which was to determine the efficiency of combines with respect to (1) cutting close to the ground surface, (2) different rates of travel, (3) cylinder and concave clearance, and (4) cylinder speed.

For this work two different makes of machines were used, each having different types of cylinders and straw racks. The study was made with four varieties of wheat, namely, Trumbull, Gladden, Thorne, and Fulhio.

Much thought was given to the planning of the work, particularly in regard to the standardization of the tests. The machines were given a thorough test for proper adjustment of cylinder speed, cylinder and concave clearance, and sieve opening. After the actual tests began no further changes were made, even when the machine was handling the maximum amount of material. Sections of the plots were selected for the tests where the crop was standing up well, of uniform height and yield, and where the ground surface was more or less level. All back furrows or dead-furrows were eliminated from the test areas; and all tests were run on the same side of the plots and in the same direction. No tests were made until the grain had reached a moisture content of 15 per cent or less. The height of stubble was carefully checked before each test by first setting the cutterbar when the machine was standing, and again rechecking when the machine was moving. The length of stubble was established at 6, 9, 12, and 15 in. The height of the crop was also measured. In order to avoid as much irregularity as possible between the two types of machines, they were alternated in such a way that both machines would be operating on a particular test at approximately the same section of each plot. The same tractor, operating in low gear, was used throughout the full series of tests.

Records were kept of the grain losses at the cylinder, straw rack, shoe, and cutterbar. In addition, power requirements were secured for both power take-off and drawbar. This was done by the new dynamometer developed by the agricultural engineering department of Ohio State University. No attempt was made to secure costs of combining because the nature of the tests and their limited scope would have made such data worthless. The crop was standing up fairly well, although a few of the varieties were slightly straw broken which naturally increased the cutterbar losses to some extent.

Results of Tests. Apparently the variety of grain and machine adjustment have much influence on grain losses. The stiffness of straw is an important factor both from the standpoint of cutterbar loss and in threshing. Varieties with a stiff straw will naturally lessen the cutterbar loss because the heads will stand more erect and not droop to the ground. A variety with a stiff straw will not be broken up as much by the cylinder; therefore, the grain will sift through more quickly.

In some cases, particularly on one machine, the straw was pulled back through the cylinder a second time. This led to much bunching on the straw rack resulting in heavy rack losses. The rack capacity is usually the limiting factor in threshing efficiency, and there was considerable difference between the two machines in this respect.

The tonnage of straw passing through the machine varied from 0.97 to 3.52 tons per hour depending upon the variety of grain and the height of cutting. As previous tests have indicated, little loss resulted at the cylinder regardless of the amount of material passing through the machine. The cylinder loss never amounted to over 0.42 per cent, and this was accomplished with a cylinder and concave clearance of 80 per cent of the maximum. This setting was arrived at from results of preliminary tests. The Trumbull wheat seemed to be the hardest to shell as the cylinder loss was slightly greater at practically all heights of stubble. The Thorne variety showed the lowest cylinder loss.

It is to be expected that high rack losses will result if the combine is operated at low stubble. Although all machines were operated in low gear, the rack loss alone, on one variety at a 6-in stubble height, amounted to 26.5 per cent. With a yield of 2691.3 lb per acre, this is a loss of 713.2 lb per acre, or approximately 13 bu. When the machine was set for a 10½-in stubble, the greatest loss was 5.6 per cent. In the case of a 15-in stubble the loss was practically negligible. On the other machine the loss was never over 1.4 per cent regardless of the variety of grain and height of stubble. The average amount of straw passing through the machine per hour at the 6-in height of stubble was as follows: Gladden, 6400 lb; Thorne, 5674 lb; Trumbull, 7000 lb; Fulhio, 3355 lb. The shoe losses, although not nearly so great, show results in practically the same relationship as those on the straw rack. When operating at a 6-in stubble, the greatest loss was only 1.35 per cent. There was also a noticeable difference with the machine and variety of grain.

Total grain losses are affected by the extent of total machine and cutterbar losses. When machine losses were high at the short stubble, the total losses were also high, but if the machine losses were low at the short stubble, then the total losses were greater at the high stubble. It will require, however, very fine and accurate adjustment of the machine to reduce machine losses to a point where the total losses will be less at the short stubble than at the long stubble.

In summing up the results, it must be remembered that the machines were adjusted as accurately as possible, and the tests were made under the most ideal conditions. It is doubtful if any farmer would have his machine operate in like manner; therefore, the machine losses may be expected to be doubled in many cases of actual farm operation. From the results of this work it is quite evident that if a combine is operated at a stubble height much lower than 10 in, considerable grain losses will result, and that these may be of such magnitude to more than counterbalance the value of the straw.

[1] Paper presented December 1, 1941, at the fall meeting of the American Society of Agricultural Engineers at Chicago, Ill. A contribution of the Power and Machinery Division. Author: Research agricultural engineer, Ohio State University.

Maintaining Open Drainage Ditches by Grazing

By Howard Matson

MEMBER A.S.A.E.

THE effect of grazing on the maintenance of open drainage ditches has been studied for the past three years in several areas in south Louisiana where CCC camps have been assisting in the rehabilitation of existing drainage facilities. The value of grazing as a means of controlling vegetative growth in open drainage channels has been amply demonstrated in these areas.

The average annual rainfall along the Louisiana gulf coast varies from 50 to 60 in, the temperature seldom drops below the freezing point, and most of the soils in the cultivated areas are highly productive. Because of these factors the growth of vegetation is very rapid, and open ditches which are not grazed or otherwise maintained soon lose most of their carrying capacity. Studies made by the Lafayette, La., CCC camp show that drainage ditches may become almost completely choked with vegetation in an amazingly short time.

A branch of Coulee Iles des Cannes, in Lafayette Parish, was the first ditch rehabilitated by the CCC camp. After rehabilitation, the ditch had a bottom width of 15 ft and was 4 ft deep. A waterstage recorder was installed on this ditch, and run-off measurements made for several years. Two years after the ditch had been rehabilitated it was found that the value of n in Kutter's formula had increased from 0.025 to 0.22, showing that the carrying capacity of the ditch had decreased to approximately 10 per cent of its original capacity, caused by growth of grass and indigo.

Willows, saw grass, alligator grass, water hyacinths, and cattails cause most of the choking and filling of drainage ditches and are the vegetative types most difficult to control. While some of these vegetative types are not actually grazed by livestock, they are effectively controlled in shallow water and along well-shaped ditch banks by the trampling which occurs in a closely grazed pasture. Even in a wide bayou saw grass, alligator grass and water hyacinths make such a dense growth, if uncontrolled, that boats are unable to use the waterway. The top growth of water hyacinths is usually killed by a freeze and afterward sinks to the bottom. New growth rapidly covers the surface of the water. Over a period of years this greatly reduces the depth of the ditch or waterway. A very good example of this is Bayou Blue, in Lafourche and Terrebone Parishes. This bayou was navigable by small boats within the memory of the older residents along the bayou. When the bayou was rehabilitated by the Thibodaux CCC camp in 1938, it had become completely closed by decayed vegetation, mostly water hyacinths. Approximately 6 ft of this decayed vegetation was removed from the bottom, and only at the upper end of the ditch did the excavation reach down to the original earth bottom of the bayou.

Sodding of ditch banks in pastured areas near the Louisiana gulf coast is not usually necessary, because of the rapidity with which carpet grass or Bermuda grass becomes established on ditch banks by spreading from the adjacent pasture. In areas further north, however, the ditch banks should be sodded following initial excavation or rehabilitation, to control erosion and the growth of undesirable vegetation. Where ditch banks are to be pastured, the side slopes should not be steeper than 2-to-1, and 3-to-1 side slopes are much to be preferred.

The accompanying illustrations show clearly that drainage ditches in south Louisiana which are not pastured, or otherwise maintained, may become almost completely choked and filled within 5 years, while ditches which have been closely grazed are still in good condition after 20 years or more of service. The use of moderate slopes, seeding or sodding, and grazing of ditch banks for the control of erosion and undesirable vegetative growth should be effective in most sections of the United States. To make this possible it will be necessary to fence the ditch, including a strip of land on each side of it, wherever a main or lateral ditch passes through or by land which is not already in pasture, and to provide swinging flood gates at each fence crossing. Arrangements for community grazing may be made to reduce the number of flood gates needed.

The objection is frequently raised that the farmer cannot afford to retire valuable land on each side of the ditch from cultivation, and that the cost of fencing the ditch and a strip of land on each side is too great in comparison with the amount of pasturage obtained. However, on at least one side of the ditch this area is usually occupied by a spoil bank. It should be pointed out, moreover, that the primary objective of such fencing is not to obtain pasture, but to provide for maintenance of the ditch. A comparison of the cost of retiring land, fencing the ditch, and grazing it, with other methods of maintenance, for a period of 10 years or more will show that a great deal of labor and money can be saved by providing a means of grazing the ditch banks.

Paper presented February 4, 1942, at a meeting of the Southern Section of the American Society of Agricultural Engineers at Memphis, Tenn. Author: Chief, regional engineering division (Region 4), Soil Conservation Service, U. S. Department of Agriculture.

(Extreme left) This ditch—Anselm Coulee, west of Youngsville, La.—is about 20 years old and in fair condition. Closer grazing probably would have kept it in better condition • (Left center) A closely grazed ditch in good condition—Coulee Darby, below Youngsville, La. Ditch dug in 1920; picture taken in 1941 • (Right center) Bayou Parc Perdue, Youngsville, La. No grazing or maintenance. Ditch dug in 1936; picture taken in 1941 • (Extreme right) View of another section of Coulee Darby. Section beyond fence not grazed

NEWS

A.S.A.E. Annual Meeting to Feature Wartime Program

THE annual meeting of the American Society of Agricultural Engineers to be held at the Hotel Schroeder, Milwaukee, Wisconsin, June 29 to July 1, will give particular emphasis this year to the relationship of agricultural engineering to wartime demands upon agriculture. Since the food-for-freedom program initiated by the federal government involves tremendously increased production from American farms, this among other things stresses the unusual necessity for increased efficiency and economy in all farming operations. It is obvious therefore that the agricultural engineer, perhaps to a greater extent than any other specialist serving agriculture, has a most important part to play in the present emergency, and it is for that reason that the A.S.A.E. meeting is being planned to assist agricultural engineers in rendering the most effective service possible in connection with the wartime demands upon that industry.

The meeting this year will be of three days duration instead of four as in the past, and in order to get into three days almost as much program as has been customary to offer previously in four days, a larger proportion of the time from June 29 to July 1 will be devoted to formal programs of papers, reports, and discussions dealing with the various phases of agricultural engineering.

While a buffet supper, general get-together, and entertainment is being arranged for those who arrive at Milwaukee on Sunday, June 28, the meeting sessions will get under way the first thing on the morning of Monday, June 29. Three concurrent programs—power and machinery, farm structures, and soil and water—will be presented during the forenoon period.

The power and machinery program at this session will feature such subjects as "An Engineering View of Wartime Farm Production," "Improved Economies in the Use of Labor, Power, and Machines," "Duty of Agricultural Machines from a Design Point of View," and "Duty of Agricultural Machines in Farming Practice."

The farm structures program for the same period will include papers on the following subjects: "Remodeled Frame Barns to Meet Wartime Needs," "Concrete Construction Without Critical Materials," "Relative Ventilation Rate and Volume of Air Required for Farm Animals," "Housing Requirements for Dairy Cows, Hogs, and Poultry," and "Methods of Moisture Drainage for Silos."

The soil and water program for the Monday forenoon period will feature contributions of the Committee on Hydrology and the following papers: "Hydrologic Co-efficients for Grass-lined Ditches," "Relation of Drainage to the Victory Program in Agriculture," "Recent Studies of Drainage Problems," and "Progress in Some Engineering Phases of Soil Conservation in Illinois."

The afternoon period of Monday, June 29, will be devoted to two concurrent programs. One on grassland farming will feature four papers: "The Relation of Grassland Farming to Soil and Water Conservation," "The Drying of Young Grasses for Seed," "Recent Developments in Hay Handling Equipment," and "Trends in Hay Harvesting Methods."

Concurrently with this program will be one devoted to subjects of special interest to the rural electrification group, for which the following papers have been scheduled: "Some Food Dehydration Fundamentals," "New Research Information on Farm Type Frozen Food Cabinets," "Continuous Electric Soil Pasteurization," "An Educational Program in the Care, Repair, and Use of Electrical Equipment," and a paper in three parts dealing with RS-4 lamps, wet cooling of poultry, and the all-electric greenhouse.

The three particular features for Monday evening include the dinner given to A.S.A.E. student branch members attending the meeting by the International Harvester Co., and two concurrent programs of the extension and research groups, sponsored by the Committee on Extension and the Committee on Research of the Society, respectively.

The first general session of the meeting will be held Tuesday forenoon, June 30, the particular feature of which will be the annual address of the president of the Society, Geo. W. Kable, editor of "Electricity on the Farm." In addition there will also be an address by J. Dewey Long, agricultural engineer, Douglas Fir Plywood Association, on farm structures problems growing out of wartime conditions.

Tuesday afternoon will be devoted to the educational group program, which will include an address by a prominent dean of agriculture on the professional and service functions of agricultural engineering, a report on the progress of the nation-wide farm machinery repair program, a report on training programs to meet wartime need, a report of the Committee on Curricula, and several other items of particular interest to agricultural engineers in educational work. The annual business meeting of the Society will follow this program.

On Tuesday evening those in attendance will have the privilege of attending meeting programs sponsored by one or more of the Society's technical divisions, including one on blackouts for farm buildings, to be sponsored by the Rural Electric Division, or several optional entertainment programs including a municipal open air concert in Washington Park, for which Richard Crooks is the scheduled artist.

The program for Wednesday forenoon, July 1, will be a general session, the theme of which is "How Can the Demand for Increased Farm Production in 1943 Be Met?" The speakers for this program will include a prominent dean of agriculture speaking from the viewpoint of agriculture, a prominent executive of the farm equipment industry speaking from the viewpoint of that industry, and a prominent agricultural engineer speaking from the viewpoint of the agricultural engineering profession.

The program for Wednesday afternoon will also be in the form of a general session built around the theme, "Gearing Agricultural Engineering to the War Effort." Several agricultural engineers, including some serving the WPB, will give brief talks, after which the session will be thrown open for general discussion with a view to crystalizing Society plans for assisting the agricultural engineering profession in making the most effective contribution possible in the war effort.

The ASAE annual dinner, always the climax of the Society's annual meeting, is scheduled for Wednesday evening, at which time the 1942 awards of the John Deere and Cyrus Hall McCormick gold medals will be made to recipients whose names will be announced a short time prior to the meeting.

Printed programs of the meeting will be available about June 1, and any information about the meeting may be obtained from the headquarters of the Society at St. Joseph, Michigan.

A.S.A.E. Meetings Calendar

June 29 - July 1—Annual Meeting, Hotel Schroeder, Milwaukee.

November 30 - December 2—Fall Meeting, Stevens Hotel, Chicago

A.S.A.E. Members Serving the WPB

AT present there are at least five members of the American Society of Agricultural Engineers who are serving with the War Production Board in Washington.

Three of them are in the Farm Machinery and Equipment Branch, division of industry operations. *Stephen Mahon,* executive vice-president of James Manufacturing Co., is chief of the dairy, poultry, and miscellaneous equipment section, and *C. E. Frudden,* executive engineer, Allis-Chalmers Manufacturing Co., and *Arnold P. Yerkes,* in charge of farm practice research, International Harvester Co., are technical consultants in the Farm Machinery and Equipment Branch.

Oscar W. Meier, formerly agricultural advisor to the administrator, REA, is now chief of the farm machinery and equipment unit, Division of Civilian Supply, WPB, and *E. J. Hergenroether,* metallurgist of International Nickel Co., is a technical consultant in the WPB Bureau of Industrial Conservation.

(News continued on page 172)

Applicants for Membership

The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

John F. Benham, agricultural agent, Pennsylvania Railroad. (Mail) PRR Station, Richmond, Ind.

John Heilman, farm management specialist, Farm Security Administration, USDA. (Mail) 108 W. Beaver Ave., State College, Pa.

Max C. Jensen, farm agent, Pine Ridge Indian Agency, USDI. (Mail) Kyle, S. D.

William W. Kirven, Jr., RR No. 1, Darlington, S. C.

Earl M. Lewis, P.O. Box 5507, College Station, Tex.

Ed. C. Milliken, general manager and treasurer, The Bowerston Shale Co., Bowerston, Ohio.

F. Duffy Murry, project engineer, Farm Security Administration, USDA. (Mail) P.O. Box 431, Williston, N. D.

Bruce E. Pettit, P.O. Box 1788, College Station, Tex.

William M. Roberts, junior agricultural engineer, Bureau of Agricultural Chemistry and Engineering, USDA. (Mail) P.O. Box 246, Ellisville, Miss.

Stanley L. Tallman, agricultural engineering specialist, Department of Agriculture, Winnipeg, Man., Canada. (Mail) 251 Moorgate Blvd.

Medford T. Thomson, district engineer, Geological Survey, USDI. (Mail) 5 North Rhodes Center, Atlanta, Ga.

J. Arthur Weber, trainee, International Harvester Co. (Mail) 1114 W. Illinois, Urbana, Ill.

TRANSFER OF GRADE

Dale L. Bidwell, work unit leader, Neches-Sabine Soil Conservation District, Soil Conservation Service, USDA. (Mail) Tyler, Tex. (Junior to Member)

Arlee C. Hanson, district conservationist, Soil Conservation Service, USDA. (Mail) 219 Carrollton St., White Hall, Ill. (Junior to Member)

Wm. J. Promersberger, assistant professor of agricultural engineering, North Dakota Agricultural College, Fargo, N. D. (Mail) 1321 N. 2nd St. (Junior to Member)

G. E. Wenzloff, in charge of cane harvester department, United States Sugar Corp., Clewiston, Fla. (Associate to Member)

Student Branch News

PENNSYLVANIA

By James B. Kistler, Scribe

THE meeting of the Student Branch of the A.S.A.E. at Pennsylvania State College held April 13 was in the form of a 6 o'clock banquet at the Nittany Lion Inn. Forty-three students and faculty members attended the much enjoyed social meeting.

The Branch was privileged to have as its speaker, Mr. A. W.

In this picture Arthur W. Turner (third from left), educational adviser, International Harvester Co., is being presented with a certificate of honorary membership in the Pennsylvania Student Branch of A.S.A.E. The presentation was made by J. B. Kistler, scribe, with other Branch members looking on

Turner, educational advisor of the International Harvester Co. Mr. Turner's topic was "Agricultural Engineering in 1942—Its Opportunities and Responsibilities". He first outlined briefly the ag engineer's place in the present emergency and urged all undergraduates to complete their college training in order to be most valuable to the country now and to be prepared for the future. Mr. Turner believes there will be vast new fields opening up for ag engineers in the near future. New crops which are now being grown and will be grown more extensively for use in making plastics and synthetic products are demanding newly designed machinery for their efficient and large-scale production. The speaker pointed out that ag engineers have failed to get the publicity which they rightfully deserve. In spite of this, many chief engineers of large companies are recognizing them and prefer to hire men trained in that field.

At the close of the meeting, Mr. Turner was presented with a certificate declaring him an honorary member of the Penn State Branch.

The booth operated by the ag engineers at Penn State's Ag Frolic, April 18, was a big success. Ag Frolic is an annual social affair sponsored by the school of agriculture and is modeled after the old county fair. Each club in the ag school operates a so-called "gambling booth" and those attending are furnished with paper "money" at the gate. Music for dancing provides a perfect setting for an enjoyable evening.

The meeting scheduled for March 30 was canceled because of a 32-inch snowfall the day before.

TEXAS

By W. Tip Hall, Scribe

THE Barnyard Frolic, one of the outstanding annual campus dances at the A. & M. College of Texas, was a great success again this year. At the last meeting before the dance, the members of the Student Branch of A.S.A.E. moved the machines out of one of the large machinery laboratories and put up the decorations. Couples came in every type of costume that could possibly be thought of, making it a very colorful affair. A prize was awarded to the best-costumed couple. The grand march was led by two tractors driven by members of the Branch. Everyone took part in the grand march, and at that time the judges picked the best-costumed couple.

Plans have been completed for the merit system set up by a committee of the Branch to encourage greater activity by the individual members. A committee went through each man's past record and made a list of his activities. It was found that three men are eligible for the award. These men are W. H. Crump, J. W. Autry, and Gus Boesch.

The Branch will make its annual award again this year for the outstanding agricultural engineer. Nominations were held for this award, and at the second meeting in April the three highest men voted upon. The award went to E. B. Hudspeth, a graduating senior, who has done much for the Branch.

As the Branch is going to continue to function through the summer, because of the twelve-month school system here, officers for the summer semester will be elected at the close of the spring semester.

A nominating committee composed of one faculty member and five senior Branch members selected three men for each office. Voting is done by secret ballot. The results of the election will be announced at the annual spring picnic held just before the close of the school year.

Two Branch members and several faculty members went to the Southwest Section meeting of the A.S.A.E. which was held at Shreveport, La., on April 4 and 5. The Branch members were W. H. Crump, president, and George Stanford, a senior.

GEORGIA

DR. A. S. EDWARDS, head of the psychology department at the University of Georgia, was the guest speaker at the first spring quarter meeting of the Georgia Student Branch of A.S.A.E. Centering his unusually interesting remarks around the methods by which human beings reach their conclusions, Dr. Edwards gave us some idea of the vast effect which experience has on an individual. Branch members showed a great deal of interest in the discussion which followed Dr. Edward's talk.

On the evening of April 18, the Branch held its annual barbecue-dance at Charlie's Place, in honor of the seniors. About 60 faculty members, students, and others attended. Highlighting the program was the presentation of honor keys to the qualified members, and the faculty award to the most outstanding senior for meritorious achievement in the field of agricultural engineering.

The award, which consists of a one-year membership in A.S.A.E., and the engraving of the recipient's name on an honor plaque, was won this year by E. T. Mims. The students who received honor keys were W. D. Kenny, Billy Strauss, and Irby S. Exley.

Agricultural Engineering Digest

A review of current literature by R. W. TRULLINGER, assistant chief, Office of Experiment Stations, U. S. Department of Agriculture. Copies of publications reviewed may be procured only from the publishers at the addresses indicated.

TESTS OF 106 COMMERCIAL CEMENTS FOR SULFATE RESISTANCE, *D. G. Miller* and *P. W. Manson.* (Minn. Ag. Exp. Sta. coop. U.S.D.A. et al.) Amer. Soc. Testing Matls. Proc. (Philadelphia), 40 (1940); abs. in Rpt. (1940) of Minn. Ag. Exp. Sta., St. Paul. Concrete cylinders 2x4 in were immersed for 5 yr in 1 per cent solutions of magnesium and sodium sulfates, and in the water of Medicine Lake, S. D., this lake having had a 12 per cent average salts content, mainly magnesium and sodium sulfates, during the test period. Changes in the length of the cylinders, taken as an index of volume changes, were determined. An increase of 0.01 in was assumed to be equivalent to complete failure of the cylinder. The lake-water cylinders were tested for strength after 5 years' immersion as compared with the strength of the cylinders held 1 yr in tap water in the laboratory.

It was found in part that, on the basis of tests of 106 commercial cements, specifying an upper limit of 5.5 per cent for the calculated compound $3CaO.Al_2O_3$ would have come as near to securing cements of high resistance to attack by magnesium and sodium sulfate as reasonably could be expected of a specification, and at the same time this limit would have eliminated all cements of low resistance.

AGRICULTURAL ENGINEERING INVESTIGATIONS (NEVADA). (Partly coop. U.S.D.A. et al.) Nevada Ag. Exp. Sta. (Reno) Rpt. (1940). The report notes improvement in the accuracy of prediction of summer stream flow in the Humboldt River, by J. E. Church and C. Elges; and an inventory and history of the agricultural land resources of the basins of the Truckee, Carson, and Humboldt Rivers, and minor streams, and an inventory and history of the water resources of the Truckee, Carson, and Humboldt Rivers, and minor river basins, both by G. Hardman and H. G. Mason.

AGRICULTURAL ENGINEERING INVESTIGATIONS (WASHINGTON). Western Washington Exp. Sta. (Puyallup) Rpt. (1940). This report notes experiments, by M. S. Grunder, in which the chimney principle was successfully applied for the ventilation of stacks of undercured hay built up around open wooden frameworks or around a sheet-metal cylinder withdrawn after completion of the stack. *(Continued on page 176)*

"Controlling Erosion in Farm Drainageways"

(Continued from page 148)

tural engineering subject concerned—otherwise it will not be a real contribution to the profession. For this reason I would like to see a paper of this type as complete and specific as possible. In the case of farm drainageways the knowledge may be meager, but still there is more than this contribution admits.

Apparently these recommendations were intended to apply only to one section of the country. This is inferred by the statement: "Bluegrass is probably the most desirable vegetation for waterways, etc." There are sections of the country where bluegrass can not be grown and where other grasses must be used. If it was the intent to make these recommendations on a regional basis, it should have been so stated.

The expression "critical velocity" is used where "permissible", "allowable", or "safe" velocity was intended. The term "critical velocity" is used in engineering practice to describe the velocity above which flow will change from viscous to turbulent. It is also used to mean the velocity of flow when flow occurs at critical depth in a channel. It would not be well to further confuse terminology by adding another meaning.

The hydraulics of these channels have not been given a good treatment. Information is available which indicates that much higher flows can be carried over the various slopes than the quantities given. There are data available of values and permissible velocities for several grasses. These should have been mentioned.

WILLIAM O. REE

Agricultural Engineering Digest

(Continued from page 174)

AN INTERMITTENT DISCHARGE VALVE FOR THE SEPTIC TANK, *H. H. Musselman*. Michigan Ag. Exp. Sta. (East Lansing) Quart. Bul. 23 (1941), No. 4. The author describes a valve designed to be made at small cost from corrosion-resistant material and to be added to the standard equipment with very little change in the design of the tank. The valve is of a double-float type. Its construction is shown, with bill of materials, in a drawing reproduced with the paper.

EMPLOYMENT BULLETIN

The American Society of Agricultural Engineers conducts an employment service especially for the benefit of its members. Only Society members in good standing may insert notices under "Positions Wanted," or apply for positions under "Positions Open." Both non-members and members seeking to fill positions, for which ASAE members are qualified, are privileged to insert notices under "Positions Open," and to be referred to members listed under "Positions Wanted." Any notice in this bulletin will be inserted once and will thereafter be discontinued, unless additional insertions are requested. There is no charge for notices published in this bulletin. Requests for insertions should be addressed to ASAE, St. Joseph, Michigan.

POSITIONS OPEN

AGRICULTURAL ENGINEERS wanted at southern institution. Extension agricultural engineer in farm buildings—a man who is qualified to design farm structures, preparing plans, etc. Beginning salary $1800 per year. Also instructor in agricultural engineering to handle courses in farm surveying and drainage, soil and water conservation, and related subjects. Needed by opening of summer quarter, June 23. Beginning salary $2000 per year. PO-136.

SALES ENGINEER wanted. Excellent opportunity offered for young agricultural engineer with good background in farm building construction. Work involves direct sales of building material to dealers, architects, contractors. Earnings equivalent of salary of $3000.00 a year or more and unusual possibilities for advancement with rapidly expanding organization. Applicants should indicate marital status, number of dependents, selective service classification, earnings expected. PO-135

POSITIONS WANTED

AGRICULTURAL ENGINEER with B. S. degree in agricultural engineering from Iowa State College. Has four years' experience as engineer with the Soil Conservation Service and five years' experience as state agricultural conservation engineer for the Agricultural Adjustment Administration. Experienced both in engineering and administration. Thirty-two years of age, married, and have family. References upon request. PW-348

AGRICULTURAL ENGINEER with B. S. degree in engineering and M. S. degree in agricultural engineering. Experienced in college teaching, experiment station, and extension work; also factory and construction work. Especially qualified for college agricultural engineering, manufacturing, defense, construction, or trade extension work. Age above draft. PW-346

AGRICULTURAL ENGINEER with B.S. degree from midwestern college (1938) and M.S. degree from southern college (1940), desires employment with the Soil Conservation Service, in a defense industry, or in other engineering work. Has 1½ years' experience as engineer with the U. S. Soil Conservation Service in the South and in the Pacific Northwest. Familiar with agriculture in most parts of the United States. Civil Service rating as junior engineer. Eligible for reappointment. Age 35. Married. PW-345

AGRICULTURAL ENGINEER desires employment offering larger opportunity. Ten years' experience in the electric utility industry and two years' experience as an assistant extension agricultural engineer. Good farm background. Particularly qualified to handle all phases of rural electrification, pump irrigation, and farm machinery. Capable of planning and conducting educational or promotional activities. Holds a state professional engineering certificate. Thirty-six years of age. Married. References on request. PW-344

AGRICULTURAL ENGINEER with 15 years' experience in the farm equipment industry; knows both farmer and tractor and implement industry in all sections of world; especially Canada and U.S.; advertising, public relations, editorial, camera, radio; can direct a complete service for dealers and factory; knows governmental and agricultural college officials; Farm Bureau; boys' and girls' clubs, livestock and special crop associations. Will locate anywhere the right firm or industry may wish. Have production records that speak. Personal portfolio mailed on request. PW-343